# BRITISH SOCIETY
# FOR THE
# STUDY OF ORTHODONTICS

1960

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*Transactions of the*

# BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

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1960

HEADQUARTERS

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Bude
Trays, W. N.

Liskeard
Bernard, W. E.

St. Austell
Perks, E. J.

*Cumberland*

Carlisle
Roberts, G. H.

*Derbyshire*

Belper
Foster, P. L.

Derby
Eddowes, C. D. W.
McKane, N. B.
Matlock
Crowther, Miss J. M.

*Devonshire*

Exeter
Shapland, A. F. D.
Newton Abbot
Whitfield, P. F. G.
Plymouth
Burley, M. A.
Endacott, D. J.
Torquay
Turner, J. Macdougall

*Durham*

Darlington
Jameson, G. D.
South Shields
Steel, G. H.

*Essex*

Billericay
Hathaway, R. F.
Buckhurst Hill
Ta'Bois, N. C.
Colchester
Seymour, A. J. H.
Epping
Brearley, Mrs. H. E.
Goodmayes
Sherwood, H.
Hornchurch
Jadwat, I. A.
Luffingham, J. K.
Ilford
Clark, A. G.
Leigh-on-Sea
Clough, E. O.
Romford
Ritchie, J. C.
Seven Kings
Ashby, M. F.
Westcliff-on-Sea
Salter, R. C. P.
Woodford Green
Martin, H. C.

*Gloucestershire*

Bristol
Blyth, P. J.
Jackson, Mrs. S. R.
Nicol, W. A.
Stephenson, J. C.
Wilkie, J. K.
Cheltenham
Dagger, T.
Everard, G. D.
Valentine, L. H.

*Hampshire*

Bournemouth
Connars, Miss M.
Hooper, J. D.
Watson, D. C.
Wood, N. J.
Crookham Village
Lervy, Capt. W. K.
Havant
Woodward, H. A.
Portsmouth
Dickson, G. C.
Ringwood
Webb, Miss J. M.
Winchester
Broadway, R. T.

*Hertfordshire*

Barnet
Pilbeam, J. F.
Bishop's Stortford
Catchpole, O. N.
Dodd, Miss J. M.
Hitchin
Hall, J. J.
Kings Langley
Boyd-Cooper, B.
Rickmansworth
Tait, R. V.
St. Albans
Clifton, D. R.
Crawford, J. F.
Watford
Leech, H. L.
Marx, R.

*Kent*

Ashford
Glass, D. F.
Beckenham
Sandiford, H. E.
Canterbury
Bradley, P. E.
Dover
Rumble, J. D.
Gillingham
Ellis, D. S.
Hawkhurst
Black, A.
Keston
Kerr, G. A.
Orpington
Brenchley, M. L.
Petts Wood
Wood, Mrs. R. M.
Sandwich
Irwin, L. M.
Sevenoaks
Christian, G. C.
Rumble, J. F. S.
Sittingbourne
Thorn, N. K.
Tenterden
Crease, J. A.
Tunbridge Wells
Cross, Miss M.
McAlpine, A. M.
Page, G. Scott
Scoones, J. M.
Spencer, J. S.
Taylor, B. P.
White, Miss B. E. E.
West Wickham
Holmes, B.

*Lancashire*

Bolton
Powell, J. E.
Burnley
Grice, A. R.
Liverpool
Angelman, J.
Atherton, J. D.
Clifford, E. J. S.
Murray, Miss J. P.
Watkin, H. G.
Watkin, Miss P. A.
Wynne, T. H. M.
Lytham St. Annes
Lilley, W. A.
Manchester
Bailey, J. C.
Batten, A. G.
Cruikshank, A. J.
Eirew, H. L.
Hargreaves, J. A.
Hartley, D. T.
Kürer, J.
Noar, G. A.
Senior, W. B.
Whittaker, L. B.
Oldham
Hilton, R.
Wild, N.
Ormskirk
Bush, P. G.
Pogrel, H.
Salford
Miller, E.
Sarll, D. W.
Southport
Robb, G. C.
Warrington
Knowles, C. C.
Wigan
Langford, L. F.

*Leicestershire*

Leicester
Chamberlain, G. H.
Downing, F. J.
O'Brien, J. D.
Smith, K. A.
Smith, T.

*Lincolnshire*

Grimsby
Bull, C. C.
Lincoln
Greenwood, A. W.

*Middlesex*

Edgware
Hudson, J. A.
Strauss, K.
Swift, P. A.
Enfield
Dimock, J. R.
Gould, M. S. E.
Harrow
Franklyn, Mrs. J. A.
Hayes
Swift, P. A.
Hounslow
Mandiwall, H.
Ickenham
Levy, Mrs. H.
Kenton
Baker, C. D.
Pinner
Eady, B.
Ruislip
Rogers, D. A.
St. Margaret's-on-Thames
Lindon, Mrs. E. G.
Staines
Carr, A. S.
Stanmore
Cryer, B. S.

*Norfolk*

King's Lynn
English, Miss M. M.
Norwich
Steel, J. K.

*Northamptonshire*

Northampton
Hughes, H. D. P.
Phillips, J. E.

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Newcastle upon Tyne
Hallett, Prof. G. E. M.
Littlefield, W. H.
Stubley, R.
Whitley Bay
Burke, P. H.
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*Nottinghamshire*

Nottingham
Attenborough, J. L.
Frankland, W.
Hope, E. McClaren
Price, A. H. K.
Tredgold, H. V. G.

*Oxfordshire*

Oxford
Harvey, P. D.
Hayton-Williams, D. S.

*Shropshire*

Church Stretton
Knight, J.
Oswestry
Broadbent, B. T.
Shrewsbury
Scott, M. F.

*Somersetshire*

Bath
Franks, Miss F. L.
Langport
Alexander, J. M.
Taunton
Poulter, N. M.

*Staffordshire*

Albrighton (near Wolverhampton)
Williams, T. G. N.
Codsall
Huddart, A. G.
Stoke-on-Trent
Campbell, A. C.
Stone
Friend, Mrs. D. J.

*Suffolk*

Beccles
Strange, Mrs. M. C.
Ipswich
Broadway, E. S.
Churchyard, R. C.
Lowestoft
Clarkson, J. N. K.
Sudbury
Hobdell, H. G.

*Surrey*

Camberley
Friend, G. C.
Rice, V. G.
Chipstead
Burnapp, D. R.
Cranleigh
Sarson, H. S. R.
Dorking
Shepperd, R. V.
Epsom
McDonald, Mrs. S.
Esher
Manning, Mrs. J. D.
Godstone
Vaus, K. S.
Guildford
Nelson, J.
Starnes, J. A. G.
Hindhead
Ogston, R. D.
Limpsfield
Titford, K. R.
Redhill
Tittle, J. J.
Richmond
Bell, R. S.
Howard, R. D.
South Croydon
Oliver, P. G.
Surbiton
Frischmann, I.
Sutton
Bulow, C. F. H.
Walton-on-Thames
McIntosh, A. J. C.
Woking
Readings, P.
Reid, D.
Smith, G. Richards
Sperryn-Jones, G.
Worcester Park
Bradley, Miss J. A.

*Sussex*

Battle
Edworthy, S. W.
Bognor Regis
Adam, K. W.
Brighton
Greenwood, A. B.
Chichester
Robertson-Ritchie, D.
Robertson-Ritchie, Mrs. E. L.
Crawley
Dakers, G. H.
Crowborough
Bligh, A. J.
Eastbourne
Abbey, R. A.
Allcorn, A. G. T.
Barlow, E. T.
Cullingford, J. T. Powell
Down, G. R.
Graves-Morris, W. R.
Gray, N.
Griffith, H. G.
Martin, D. W.
Travis, C. H.
East Grinstead
Whitelegg, J. G.
Fittleworth
Wylde, Mrs. A. S.
Horsham
Pearsall, M. L. H.
Hove
Allan, F.
French, J. H.
Harwood, W. U.
Shenton, F. C.
Taylor, S. B.
Littlehampton
Brown, K. H.
Pevensey Bay
Winn, T. L.
St. Leonards-on-Sea
Artes, E. J.
Chisholm, I. M. G.
Young, Miss E. M.
Worthing
Bull, F. Bocquet

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Day, A. J. W.
Foster, T. D.
Hollick, R. L. B.
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Hutton, J. L.
Menezes, D. M.
Norris, N.
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Tibbatts, Mrs. M. A.
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Breakspear, E. K.
Solihull
Cutler, M.

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Chippenham
Swann, A. J.
Devizes
Campbell, Miss D. M. Y.
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Salisbury
Godfrey, O. Harcourt

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Dudley
Mole, D. O.
Great Malvern
Edmonds, W. H.
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Malvern
Wallis, R.
Stourbridge
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Heylings, R. T.
Bradford
Frazer, Mrs. J.
Wood, T. Jason
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Hull
Webb, G. H.
Leeds
Haynes, S.
Jackson, D.
Marsh, W.
Miller, J.
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Alexander, S. H.
Gardiner, J. H.
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Wakefield
Townend, B. R.

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Barry
Hellier, R. O.
Cardiff
Cousins, A. J. P.
Lewis, A. S.
Colwyn Bay
Duchesne, H. W.
Llandrindod Wells
Capleton, Mrs. L. M.
Llandudno
Jones, J. E.
Swansea
Parry, H. L.

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Ayr
Hood, M. R.
Bucklyvie
White, Prof. T. C.
Cleland
McGonigal, F.
Dumfries
Baker, A.
Dundee
Archibald, W. C.
McEwen, J. D.
Munro, D.
Ritchie, G. S.
Dunfermline
Mason, Miss E. A.
Edinburgh
Buchan, A.
Dixon, D. A.
Hopkin, G. B.
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Kemball, C. H.
Logan, W. Russell
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Aitchison, J.
Anderson, H. A.
Campbell, J.
Houston, J. G.
McCartney, T. P. G.
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Grangemouth
Stevenson, Wm.
Hawick
Govan, I. G.
Inverness
Jones, F.
Ridley, Miss D. R.
Kirkcaldy
Mears, Miss R.

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Bangor
Dallas, H. A.
Belfast
Adams, C. P

Bonnar, Miss E. M.
Brown, W. A. B.
McKeag, H. T. A.

Dublin
Dockrell, R. B.
Finn, S. D.
Fitzgerald, G. M.

Friel, Prof. S.
Keith, J. E.
Kennedy, G. F.

## VI. Isle of Wight

Ryde
Audsley, C. W.

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Bowen, E. J.
De Villiers, J. F.
Fainsinger, B. E.

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Cox, Dr. N. J.
Crisp, B. C.
Halliday, R. W.
Heath, J. R.
Horsnell, A. M.
Norton, R. Y.
Reading, J. F.
Spring, D. F.
Taylor, A. Thornton
Webb, V. P.

*Burma*
Brears, Dr. O. B.

*Canada*
Copeland, Dr. G. P.

Franklin, G.
Hackie, T. J.
Hargadon, Dr. K. L.
Mulligan, W. O.
Oliver, H. T.

*Egypt*
Chohayeb, Mrs. A.

*France*
Demoge, P. H.
Gugny, G.
Omeyer, R.

*India*
Ghosh, A. S.

*Jamaica*
Lyn, Dr. M. R.

*Malaya*
Chan, B. K.
Cheah, C. K.
Porterfield, Lt.-Col. M. F.

*Malta*
Demajo, A.

*New Zealand*
Bell, J. A.
Cook, C. C.
Gilbert, G. H.
Kean, M. R.
Lang, E. T.
Suckling, J. G. T.
Willis, L. E.

*Norway*
Engh, Olav
Krogstad, Olav
Selmer-Olsen, Prof. R.

*Singapore*
Lee Chee Onn, J.

*Southern Rhodesia*
Robson, F. F.

*Sweden*
Ahlgren, J.
Billberg, B.
Granerus, R.
Granse, K. A.
Ljungdahl, L.
Lundström, Prof. A.
Mortenson, S. Å.
Palsson, K. F.
Pihl, Miss E. M. K.
Tegner, G.
Volmer Lind, H. C.
Werner, S. H.

*Switzerland*
Hotz, Prof. R.

*U.S.A.*
Goldstein, M. C.
Gosman, S. D.
Gottlieb, A. W.
Kelsten, Dr. L. B.
Sillman, J. H.

# SOME OF THE CAUSES AND EFFECTS OF MALOCCLUSION

## AN ANALYSIS TAKEN FROM A RANDOM SAMPLE OF 1000 EAST ANGLIAN SECONDARY MODERN SCHOOL CHILDREN

By **D. P. WALTHER**, L.D.S., D.Orth. R.C.S., M.R.C.S., L.R.C.P.
*Royal Dental Hospital, London*

In the past, especially under those of the Angle school, the treatment of orthodontics was very empirical and largely a practical exercise attempting to arrange all the teeth in a perfect arch regardless of the size of the teeth, the arch, or the muscle environment. Stress was, therefore, laid on technique rather than aetiology and the relapse rate was high.

More recently, progress has been made by laying much more emphasis on the aetiology and treatment planning and thus assessing the prognosis of a case from the outset.

Numerous theories have been and are being put forward, concerning the aetiology of malocclusion, which are based on keen observations, but very little has been done to date to give these a statistical backing. It was decided, therefore, to attempt this by analysing a few of the factors which influence the occlusion of the teeth, taken from a random sample of 1000 East Anglian Secondary Modern School Children. It was also realized that very little work has been done along these lines into the effects of malocclusion on the individual, their teeth, and their surrounding tissues.

A small research project was, therefore, planned and carried out by a team from the Royal Dental Hospital.

The team consisted of Mr. P. M. C. James, Senior Lecturer in Children's Dentistry, Mr. D. A. Plint, Lecturer in Orthodontics, and myself.

The sample of 1000 children was chosen as carefully as possible in the following manner:—

1. All the children were between 11 and 13 years of age.

2. They all came from new Secondary Modern Schools in three East Anglian centres —Colchester, Chelmsford, and Norwich. Their environment was, therefore, much the same.

3. East Anglia was chosen because it tends to be a little more isolated on account of its geographical position.

4. One-third of the children were taken from each of the centres for the following reasons:—

*a.* Colchester, because it has an adequate to high fluorine content in its water-supply, between 1·2 and 2 parts per million. Therefore, quite a high proportion of children (181) had been exposed to continuous fluorine all their lives. The remainder had fluorine for varying lengths of time.

*b.* Chelmsford, where the fluorine content is intermediate and intermittent, varying somewhere between 0 and 1 part per million.

*c.* Norwich, where the fluorine content is definitely very low, only 0·17 part per million.

It was felt that this sample gave us a very valuable cross-section on which to base our project.

James examined the children for the following:—

**Caries.**—D.M.F. count (i.e., decayed, missing, and filled teeth). Those with a D.M.F. of 9 and over were considered high. Those with a D.M.F. of between 2 and 8 were average. (These were the cases which fell within the standard deviation of the mean for the total group.) Those with a D.M.F. of 1 and less were low.

**Gums.**—P.M.A. count (i.e., degree of inflammation of papilla, margin, and attachment around the upper and lower incisor teeth). Those with a total P.M.A. count of 5 and over were considered high (poor gums). Those with a total P.M.A. count of between 3 and 4 average. (These cases fell within the

Presidential Address given at the meeting held on January 11, 1960.

## CLINICAL ASSESSMENT FORM

NAME (9–10) AGE (11) SEX (1–2) DATE (3–6) No.

(33) Skeletal Classification — [1] Class I [7] Mild II [2] Class II [8] Mild III [3] Class III

(33) Frankfort–Mandibular-plane Angle — [4] High [9] Highish [5] Average [10] Lowish [6] Low

(34) Occlusal Classification — [1] Class I [2] Class II div. 1 [3] Class II div. 2 [4] Class III [5] Class II indefinite

(35) Lips — [1] Competent [2] Incompetent [3] Slight [4] Gross [5] Habit. tog. [6] Apart [7] Sep. by 21|12 [8] Normal

(36) Lip Line (Tog.) — [1] Above occlusal ½ [2] Occlusal ½ [3] Incisal tips [4] Below

(37) Swallowing — [1] Tooth together [2] Tooth apart [3] Anterior tongue thrust [4] Doubtful 50|50

(38) Circumoral Contraction — [1] Absent [2] Over 21|12 [3] Incisal tips [4] Under 21|12 [6] Present + [7] Present ++

(38) Tongue Position — [5] Between Incisors

(39) Habits — [1] Tongue to lip [2] Thumb or finger [3] Other objects [4] Age when stopped: [5] 0–2, [6] 3–4 [7] 5–6 [8] 7–8 [9] 9 +

(40) Habitual Rest Position — [1] Normal [2] Forward [3] Open

(42) Breathing — [1] Nasal [2] Oral [3] Oral-nasal [4] Nasal infection

(44) Speech — [5] Normal [6] Anterior sigmatism [7] Dyslalia [1] Cleft palate [8] Others

(45) Oral Hygiene — [3] Good [4] Average [5] Poor

(46) Upper Incisors — [1] Normal [2] Proclined [3] Retroclined [4] Crowded [5] Spaced [7] Diastema [9] Fractures [8] Local abnormalities

(49) Lower Incisors — [1] Normal [2] Proclined [3] Retroclined [4] Crowded [5] Spaced [9] Fractures

(52) Overbite — [1] Normal [2] Increased complete [3] Increased incomplete [4] Reduced [5] Edge to edge [6] Open bite

(53) Overjet — [1] Normal [2] Increased slight [3] Increased gross [4] Reversed [5] Edge to edge

(56) Early Loss Dec. — [1] Maxilla [4] Crowding [5] Mandible [8] Crowding

(63) Caries D.M.F. — [3] High (9 +) [4] Average (8–2) [5] Low (1 —)

(63) Gums P.M.A. — [6] High (5 +) [7] Average (4–3) [8] Low (2 —)

(64) Treatment — [1] None required [2] Previous orthodontic treatment [10] Requires orthodontic treatment [11] Treatment by extraction only

(65) Fluorine — [1] High continuous from birth [2] High after birth [3] Average [4] Low

(65) Group — [5] Colchester [6] Chelmsford [7] Norwich

*Fig.* 1.—Assessment form used in research analysis.

standard deviation of the mean for the total group.) Those with a total P.M.A. count of 2 and less were low (good gums).

He also noted the presence of calculus, stain, mottling, fractured incisors, oral hygiene, etc.

Flint and I gave as complete an orthodontic examination as possible. This was adjusted so that we took twice as long as James. This meant that the children could progress straight through without any hold-up and, therefore, minimal interference with school work. The schools put their medical inspection rooms at our disposal for this purpose.

## ORTHODONTIC EXAMINATION

This examination was purely clinical and we confined it to what we felt to be the minimal essentials. The assessment form used is shown in *Fig.* 1. Most of this is self-explanatory.

The dental base relationship was assessed by Ballard's method of correcting the axial inclination of the incisors and then determining the degree of overjet present. It will be noticed that it was divided into 5 groups. Skeletal I, when after correction the overjet was normal. Skeletal II, when after correction there was considerable overjet. There was no question at all in these cases that the dental base relationship was post-normal, and if a lateral skull tracing could have been available the long axis of the lower incisor would have passed palatal to the crown of the upper incisor. The mild Skeletal II group were those cases which fell between these two groups.

Skeletal III, when after correction the overjet was considerably reversed, and there was no doubt that the dental base was pre-normal. The mild Skeletal III group were those which lay between these and the Skeletal I cases.

From 100 hospital cases the difference has been worked out between my clinical assessment of dental base relationship and that obtained from lateral skull tracings. My total accuracy, including margin of error, was 93 per cent. My greatest difference was placing some of the definite Skeletal II cases as mild Skeletal II, and some definite Skeletal III cases as mild Skeletal III.

The difference appears to be connected with the morphology of the incisor teeth.

The size of the Frankfort–mandibular-plane angles was also assessed clinically, and divided into 5 groups, so as to separate the definitely high from the definitely low.

The High group = approximately 33·5° and above.

The Moderately High group (Highish) = approximately 29·5–33°.

The Average group = approximately 25–29°.

The Moderately Low group (Lowish) = approximately 21–24·5°.

The Low group = approximately 20·5° and under.

The total accuracy, including margin of error, between my clinical assessment and that taken from the lateral skull tracing was about 94 per cent.

Angle's classification was used for the occlusion, but I found I had to add a Class II indefinite group for those cases which would not fit into either Class II, division 1 or Class II, division 2 groups.

Upper incisors were said to be proclined if their axial inclination with the Frankfort plane was more than 111°, and retroclined if less than 103°.

The total accuracy between my clinical assessment and that from a lateral skull tracing was about 73 per cent, because I tended to assess all groups as slightly more retroclined than the tracing showed. This appears to be related to the morphology of the crowns.

As regards the lower incisors, these were adjusted mentally inversely with the Frankfort–mandibular-plane angle, and were said to be proclined if when the Frankfort–mandibular-plane angle was normal their axial inclination to the mandibular plane was more than 95°, and retroclined if less than 85°. Here my total accuracy was lowest at only 51 per cent, again tending towards retroclination, and may be associated with the morphology of their crowns.

The following definitions were used when assessing soft tissue morphology:—

**Competent Lips.**—"A soft tissue morphology that permits the lips to seal with the

mandible in the rest position, without any active contraction of the oro-facial musculature." It might be better and less confusing if we used the term "adequate lip morphology" in these cases.

divided into 2 groups, slight and gross, also whether usually together, apart, or separated by 21|12.

Some of the "competent" lips appeared normal, whilst others appeared overcompetent,

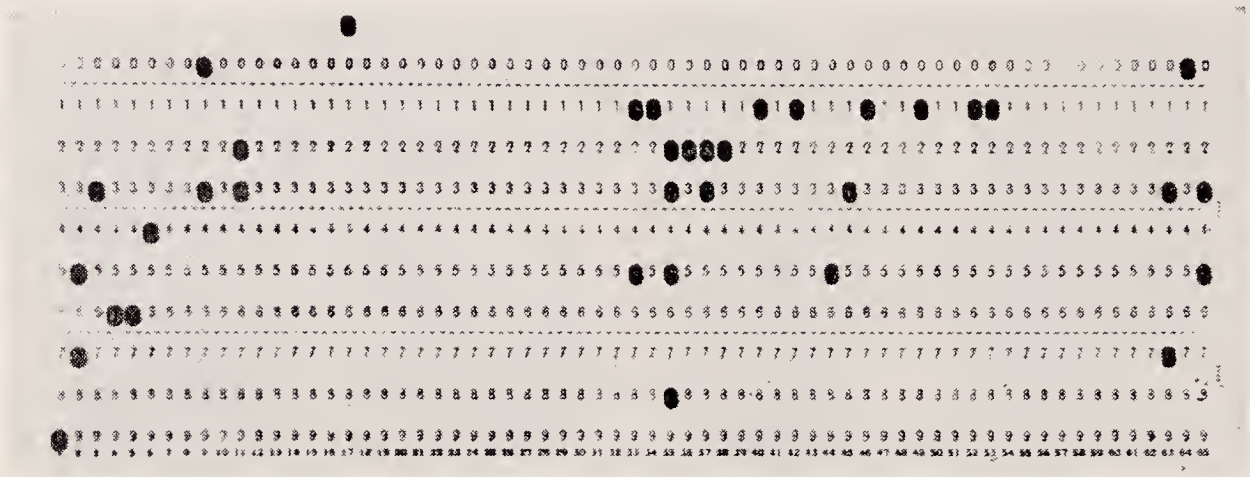

*Fig.* 2.—Example of the punch card used.

*Fig.* 3.—Girl feeding material from the assessment form on to the punch card.

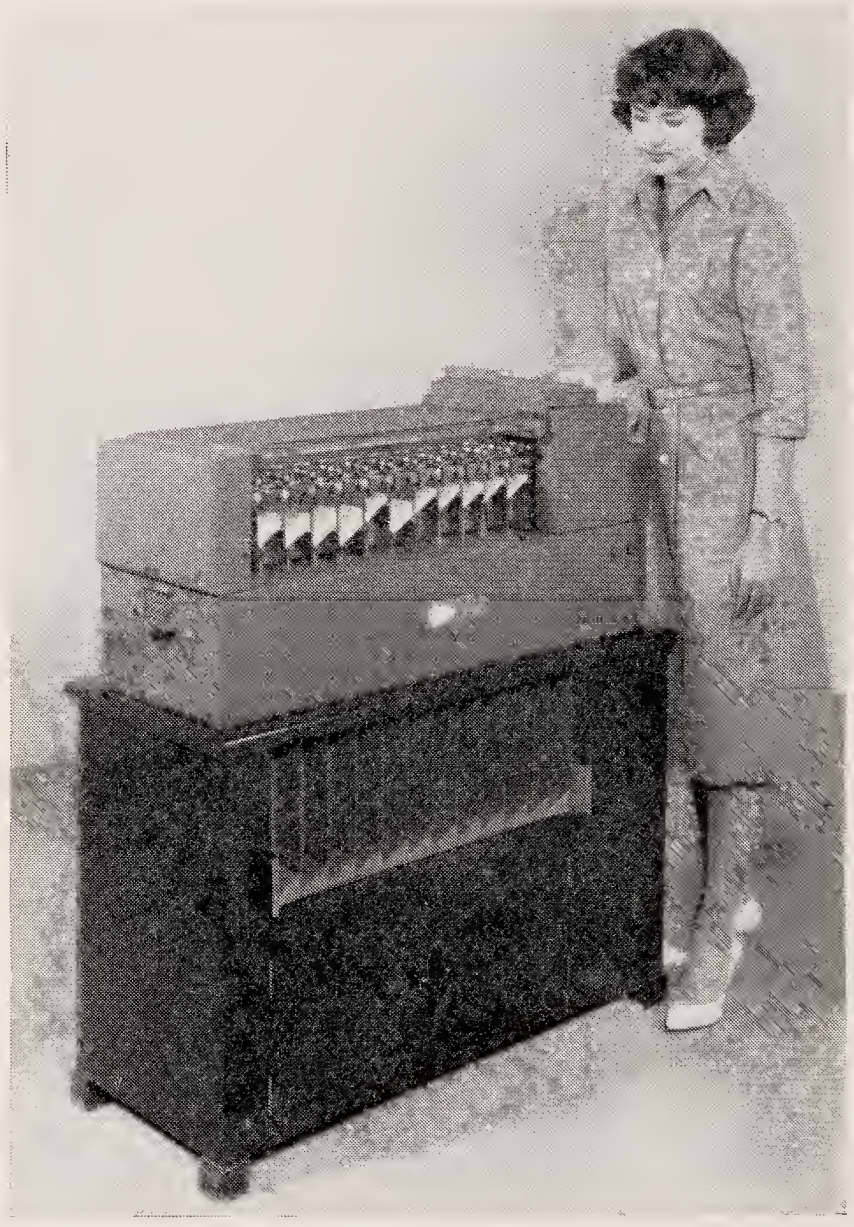

*Fig.* 4.—The Powers-Samas sorter. (*Figs.* 3 *and* 4 *by kind permission of Messrs. Powers-Samas.*)

**Incompetent Lips.**—"Here the lips are parted at rest with the mandible in the physiological rest position." Here again it might be less confusing to use the term "inadequate lip morphology". The "incompetent" lips were and quite a large number of the slightly incompetent lips appeared normal. So "normal" was added to the assessment form.

**Swallowing Behaviour.**—Whether the teeth came into light occlusion or not, and whether

there was a tongue thrust present, was assessed.

If the tongue lay between the incisors at rest, this was also noted.

The assessment form was then punched on to a Powers-Samas punch card (*Fig.* 2), and the various facts required extracted by the sorter and then brought to percentages. *Figs.* 3 and 4 show the way this was done.

*Fig.* 5 shows a pseudo-graph of the dental base relationships compared as percentages. These graphs are not true graphs in the accepted sense. What has been done is to join the summits of the various histograms. It was felt this was the clearest way of presenting and comparing the various percentage distributions. It will be noticed that out of the total group of 1000 cases, 356 were Skeletal I, i.e., 35·6 per cent. Definite Skeletal II and mild Skeletal II were 25·6 per cent and 27·7 per cent respectively, whilst definite Skeletal III and mild Skeletal III were only 4·3 per cent and 6·8 per cent respectively. (These figures are reasonably accurate as the standard error is less than 3 per cent.)

It will be noticed how the total Skeletal II tendency predominates, whilst the total Skeletal III tendency is only about 10 per cent. I have kept the 5 groups apart in order to observe any particular swing. Plint and I examined 498 and 502 cases respectively. Unfortunately, we could not both examine all the cases because of time and organization. Obviously this would have been the ideal had it been possible. However, we had previous evidence that our assessments compared fairly closely. Another factor which must be borne in mind is the fact that I examined 16 per cent more of the Colchester children, whilst Plint examined 8 per cent more of both the Norwich and Chelmsford children. The differences in these groups may also have contributed to our slight variation, or vice versa.

It will be noticed that we were much the same as regards the percentage of Skeletal I cases, but that I was slightly higher in definite Skeletal II assessment, whilst he was slightly higher in mild Skeletal II assessment. This may well be influenced by the higher relative percentage of definite Skeletal II cases in Colchester as compared with the higher relative percentage of mild Skeletal II cases of Chelmsford and Norwich.

The same slight difference will be noticed in the Skeletal III and mild Skeletal III groups.

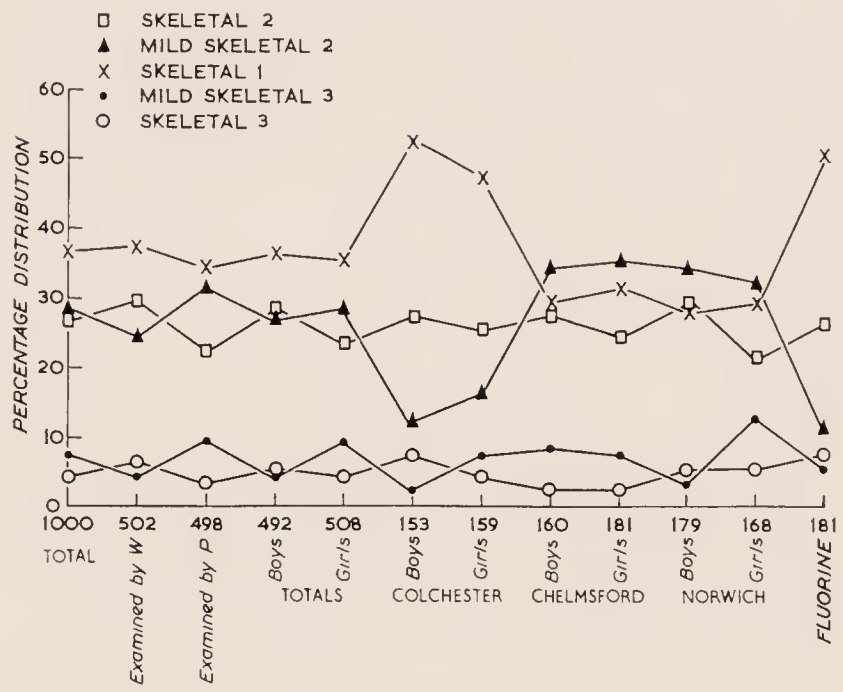


*Fig.* 5.—Dental base relationships compared.

It is also interesting to notice that a predominantly definite Skeletal II dental base relationship tends to show itself more in the boys of the various groups, and the higher the percentage the more it appears to come out in the males. This is also seen, but to a less extent, with Skeletal III cases. It is also found to be the case when the various Frankfort–mandibular-plane angle groups are compared.

In comparing the 3 groups of children it will be seen that in Colchester the percentage distribution of Skeletal I cases was significantly very high—51·5 per cent for boys and 47 per cent for girls—whilst those of the mild Skeletal II were very low, forming, as it were, a mirror image.

In both the Chelmsford and Norwich groups it will be seen that the percentage of mild Skeletal II cases is higher than average, whilst the percentage distribution of Skeletal I cases is lower than average. The percentage distribution of the definite Skeletal II cases remains extraordinarily steady.

Since there were 181 children in the Colchester group who had been continuously exposed to fluorine from before birth, it was decided to work out the percentage distribution of the various skeletal groups for these

ehildren. It was found that out of the 181 continuous fluorine cases:—

91 were Skeletal I—50·3 per cent.
20 were mild Skeletal II—11·1 per cent.
48 were definite Skeletal II—26·5 per cent.
13 were mild Skeletal III—7·2 per cent.
9 were Skeletal III—5 per cent.

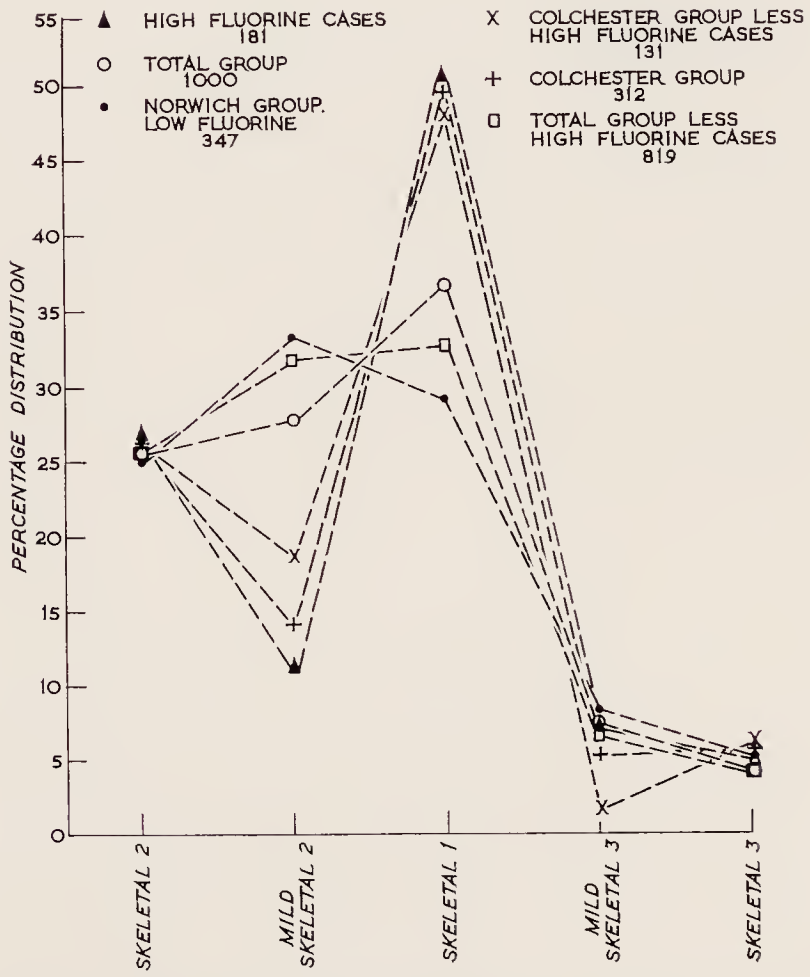


*Fig.* 6.—Dental base relationship of high and low fluorine groups compared.

This showed a significant rise in the percentage of Skeletal I cases from 35·6 per cent in the total group to 50·3 per cent, and a significant fall in the mild Skeletal II cases from 27·7 per cent in the total group to 11·1 per cent (over 8 per cent rise is significant in this case). This is a very similar picture to that of the Colchester group.

This change in the percentage distribution of Skeletal pattern may be accounted for by either the difference in the ethnic groups, or it might be due to the different fluorine content of the water-supply.

It may well be that the fluorine content has encouraged the mild Skeletal II cases to become Skeletal I, but does not affect the definite Skeletal II cases which are beyond help. This might have been caused by a slight lag in the development of the maxilla or encouragement to the growth of the mandible. The ideal situation might be to have a favourable ethnic group with a high percentage of mild Skeletal II cases on which the fluorine can act to makc them become Skeletal I.

Another graph was, therefore, drawn (*Fig.* 6) to compare the following groups:—

1. Those who had continuous fluorine from before birth—181 cases (▲).
2. The total Colchester group—312 cases (+).
3. The total Colchester group without those who had continuous fluorine from before birth —131 cases, but it should be realized that these cases had been exposed to fluorine for varying lengths of time (×).
4. The total group of 1000 cases (○).
5. The total group without those who had continuous fluorine—819 cases (□).
6. The total Norwich group of 347 cases. Here the fluorine content of the water is very low (●).

The following points are of interest, but it must be realized that the standard error per cent varies from between 3 per cent and 8 per cent according to the size of the percentage and the size of the group.

1. The percentage of cases having a definite Skeletal II dental base relationship is about the same for all groups, 25–26 per cent.
2. The picture presented by the percentage of cases having a mild Skeletal II skeletal pattern is very different. Here the total Norwich group and the total group without the continuous fluorine cases (819) are highest at 33 and 31 per cent, followed by the total group (1000) at 27·5 per cent. Then comes the Colchester group without the continuous fluorine cases (131) at 19 per cent, with the total Colchester group (312) 14 per cent, and the continuous fluorine cases (181) 11 per cent being the lowest of all.
3. The percentage of cases having a Skeletal I dental base relationship is completely the reverse way round. The continuous fluorine group, the total Colchester group, and the Colchester group without continuous fluorine comprise about 49 per cent, whilst the other 3 groups, i.e., the total group, the total group without continuous fluorine, and the Norwich group, are lowest at about 29 to 35 per cent.

4. The percentage distribution of the mild Skeletal III cases is very indefinite and has a much wider variation for the various groups than that of the definite Skeletal III cases which is localized in much the same way as the definite Skeletal II cases.

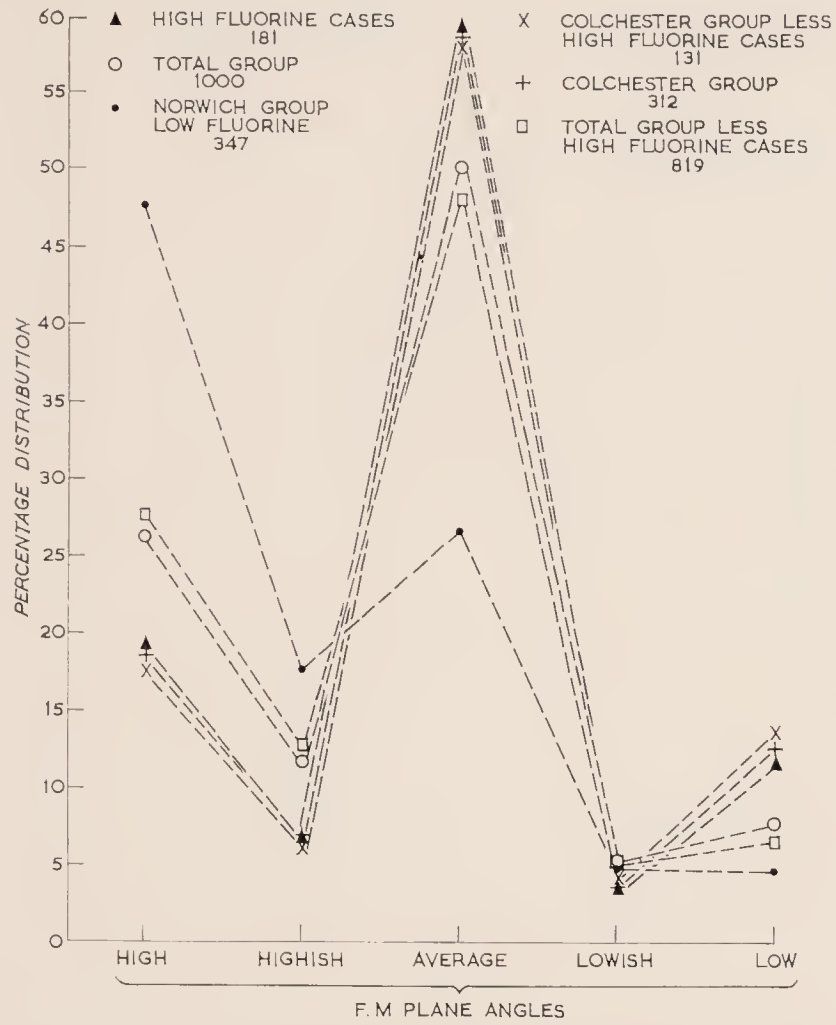


*Fig.* 7.—Frankfort–mandibular-plane angles of high and low fluorine groups compared.

It must be remembered that whilst the 181 cases had continuous fluorine since birth, the vast majority of the total Colchester group were also exposed to fluorine for varying lengths of time whilst they were living in Colchester. The Colchester group without continuous fluorine from birth (131 cases) were, therefore, exposed to fluorine for a varying length of time during their development.

There is not, therefore, sufficient evidence in this survey to be able to say whether this improvement in skeletal pattern is due to the fluorine intake or whether it is just the local ethnic group. A further survey is necessary in another fluorine area, but it does give us food for thought. It might be a useful aid to treatment if the day should come when we can give a drug to improve the skeletal form.

The effect of fluorine and/or ethnic group on the size of the Frankfort–mandibular-plane angles is also interesting, and can be seen in *Fig.* 7.

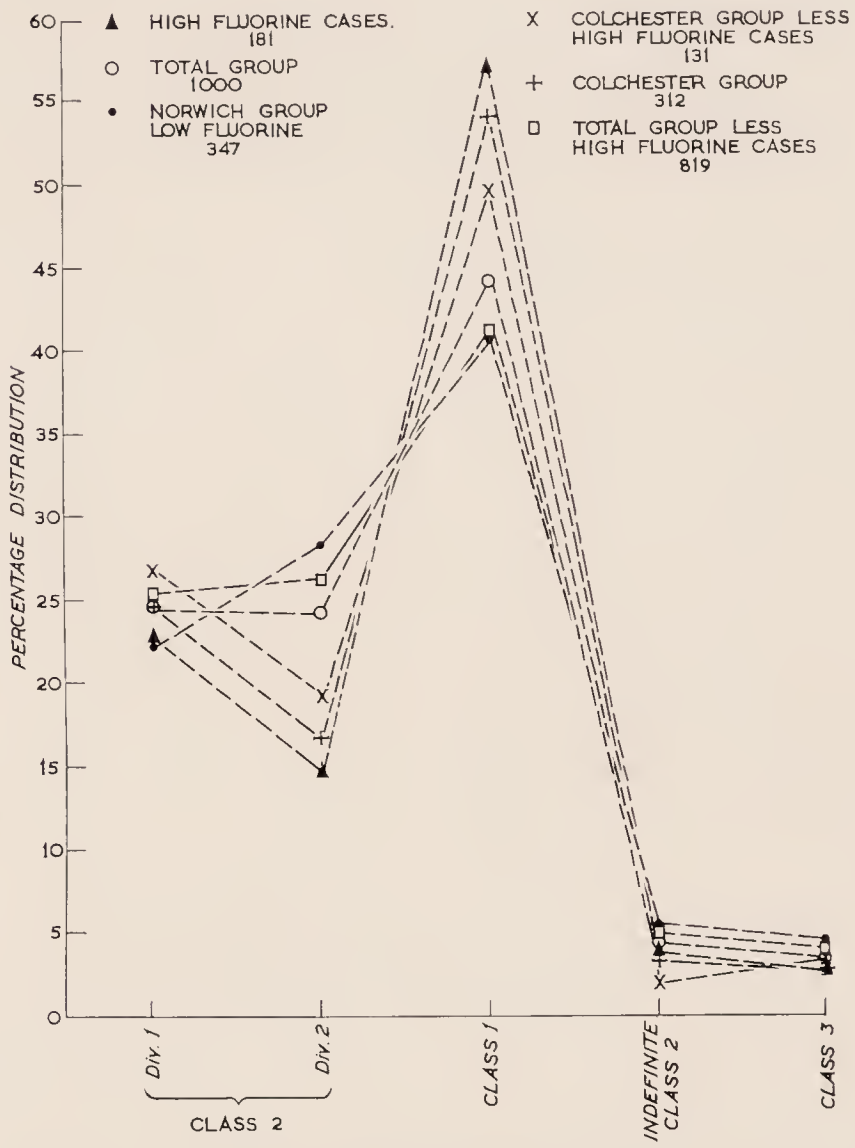


*Fig.* 8.—Occlusal classifications of high and low fluorine groups compared.

It will be noticed that the Norwich group which has low-fluorine water and the total group without the fluorine cases have the highest percentage of high and highish Frankfort–mandibular-plane angles, slightly higher than the total group cases, whereas the fluorine group and the Colchester groups have a much lower percentage. This again may be due to either ethnic or fluorine influence, or both. It will also be noticed in this graph that the percentage of average Frankfort–mandibular-plane angles is also highest in the fluorine and Colchester groups, about 59 per cent. The percentage of low Frankfort–mandibular-plane angles is also highest in the fluorine and Colchester groups.

The effect of fluorine and/or ethnic group on the various Angle's occlusal classification classes can be seen in *Fig.* 8.

It will be seen that the percentage of Angle Class I cases is highest in the fluorine group, 57 per cent, followed by the Colchester group only, 54 per cent, and then the Colchester group without fluorine, 49 per cent. Then

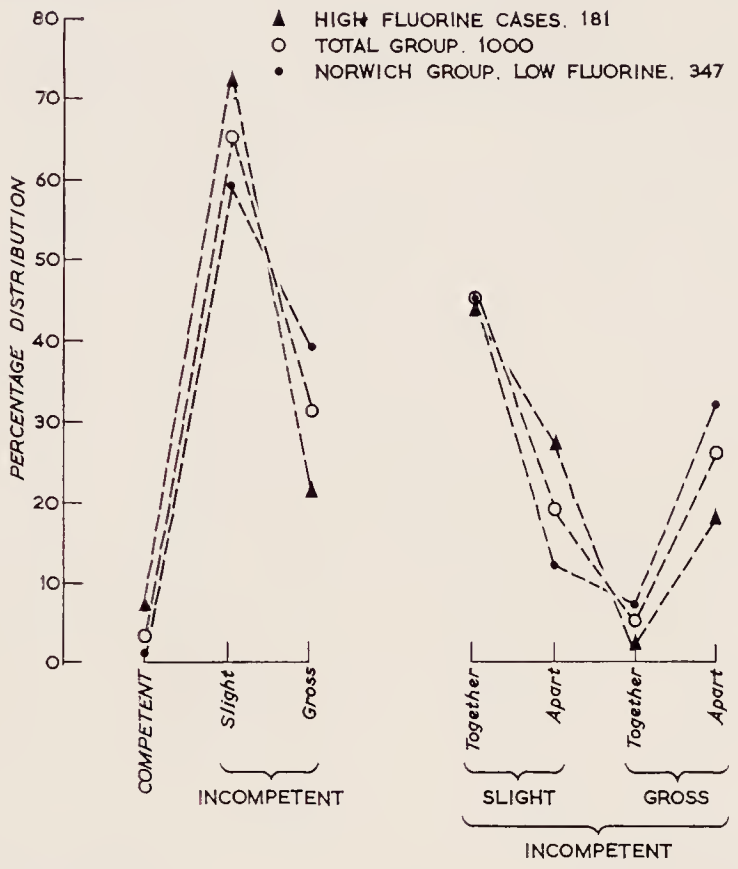


*Fig.* 9.—Various lip morphologies of high and low fluorine groups compared.

comes the total group at 44 per cent and the lowest percentage is found in the total group without fluorine and Norwich (low fluorine) cases at 41 per cent. It certainly looks as if fluorine may be playing some part in the percentage of Class I cases from this distribution. It is interesting to note that in the recent report on the Evanston fluorine study, there was a definite lowering of the incidence of malocclusion, which was not just due to the known effect of fluorine on the caries incidence and, therefore, on the early loss of teeth which is only thought to be only a minor factor in causing malocclusion.

It will also be noticed that the percentage distribution of the Class II, division 2 cases is lowest in the fluorine group and highest in the Norwich low fluorine group. This may be connected with the predominance of a mild Skeletal II dental base in these cases which might possibly have been favourably influenced by a fluorine intake, whereas the higher incidence of definite Skeletal Class II dental base relationships of the Class II, division 1 and indefinite Class II cases is too gross to be affected. Of course, we must examine more ethnic groups in other fluorine areas before we can really draw any definite conclusions. It is to be hoped that Norwich may, at some time in the future, fluorinate its water supplies, in which case a repeat assessment would be of great interest.

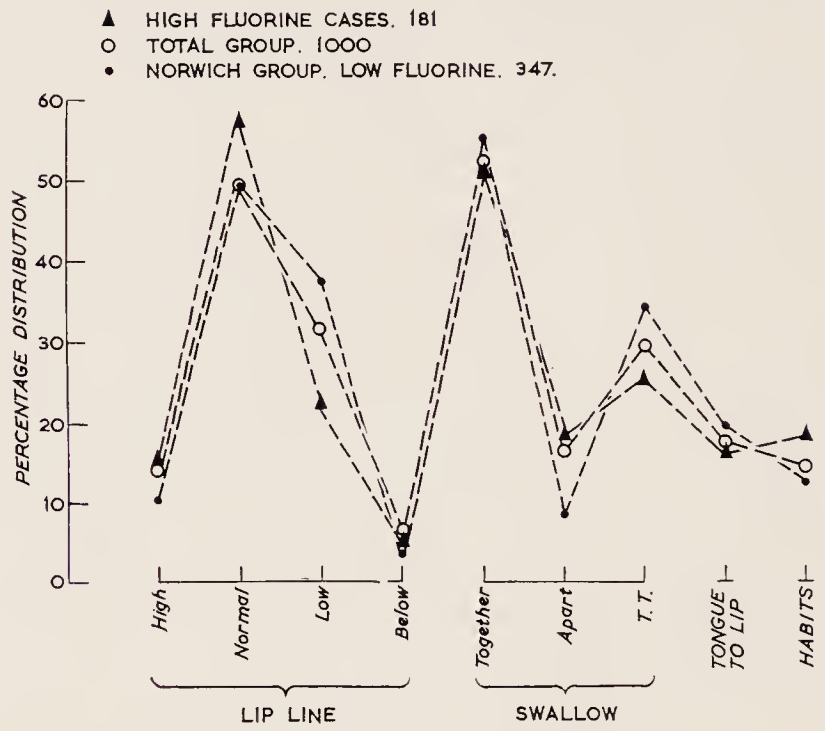


*Fig.* 10.—Various lip morphologies and swallowing behaviours of high and low fluorine groups compared.

Other graphs were then made, comparing the percentage incidence of other factors in the continuous fluorine group of 181 cases, as against the total group of 1000 cases, and the low fluorine Norwich group of 347 cases.

*Fig.* 9 shows a pseudo-graph of the percentage distribution of the various different lip morphologies. It will be noticed that the percentage distribution of cases with competent and slightly incompetent lips was higher in the fluorine group, whilst in those with grossly incompetent lips it was much lower. This may well be due to the higher percentage of Skeletal I dental bases and average and lowish Frankfort–mandibular-plane angles in the fluorine group. Whether the lips are usually held together or apart does not appear to influence the percentage distribution very much, but the percentage distribution of the slightly incompetent lips, which are held habitually together, appears lower in the fluorine group than I would have expected.

*Fig.* 10 shows a graph of the percentage distribution of the various positions of the lip

line and swallowing behaviours. It will be noticed that, in the fluorine group, the percentage distribution of a normal lip line is higher than in the total group but of a low lip line much lower, again, probably due to

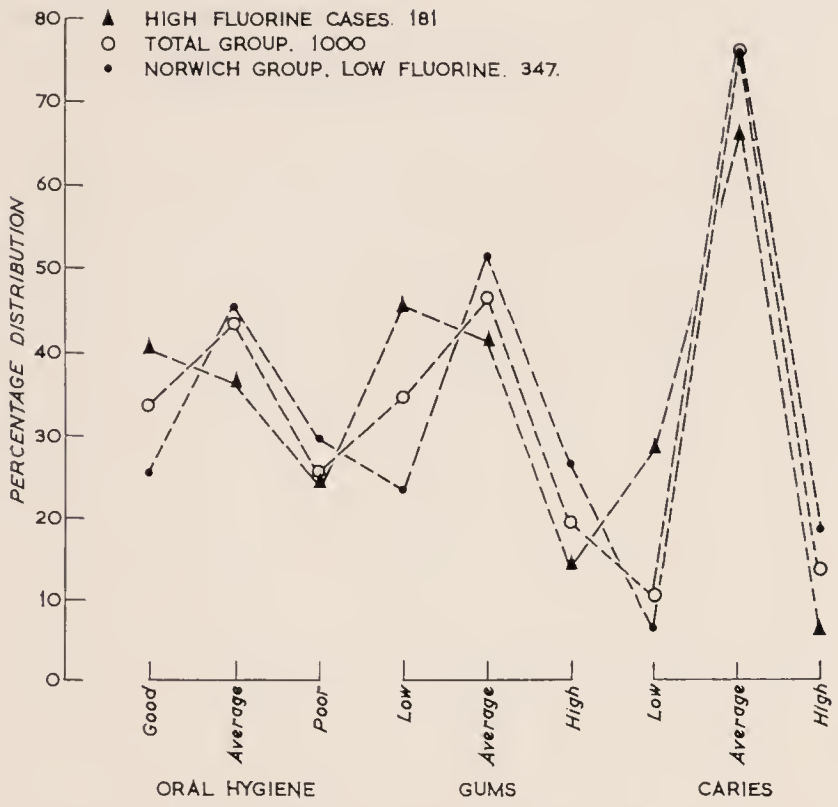


*Fig.* 11.—Oral hygiene, gums P.M.A., caries D.M.F., of high and low fluorine groups compared.

In *Fig.* 11, as would be expected, the percentage of cases having a low D.M.F. caries count (1 and under) is much higher in the continuous fluorine group, whilst those with an average D.M.F., i.e., between 2 and 8, or high count, 9 and above, were much lower.

It will also be noticed that the percentage of cases having a low P.M.A. count, i.e., 2 or

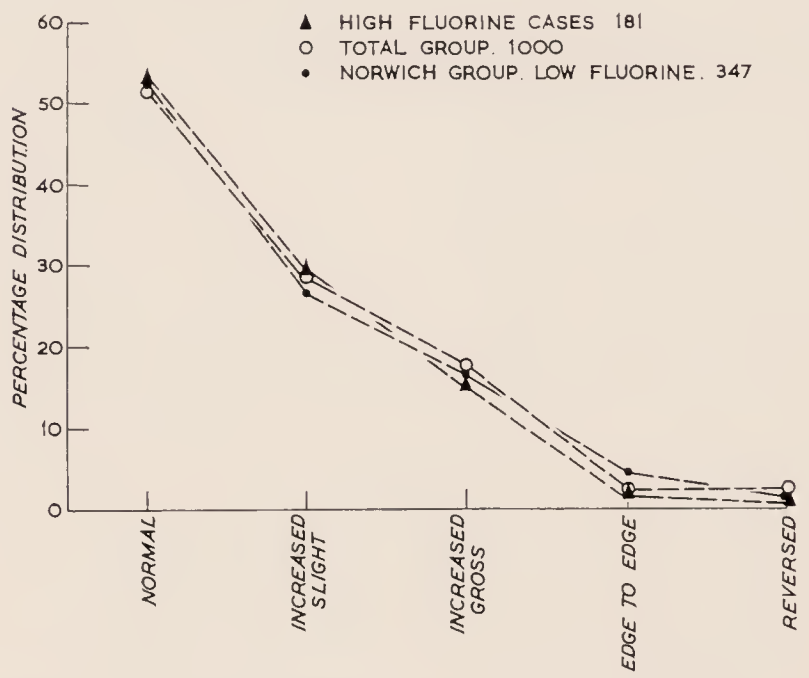


*Fig.* 12.—Various degrees of overjet of high and low fluorine groups compared.

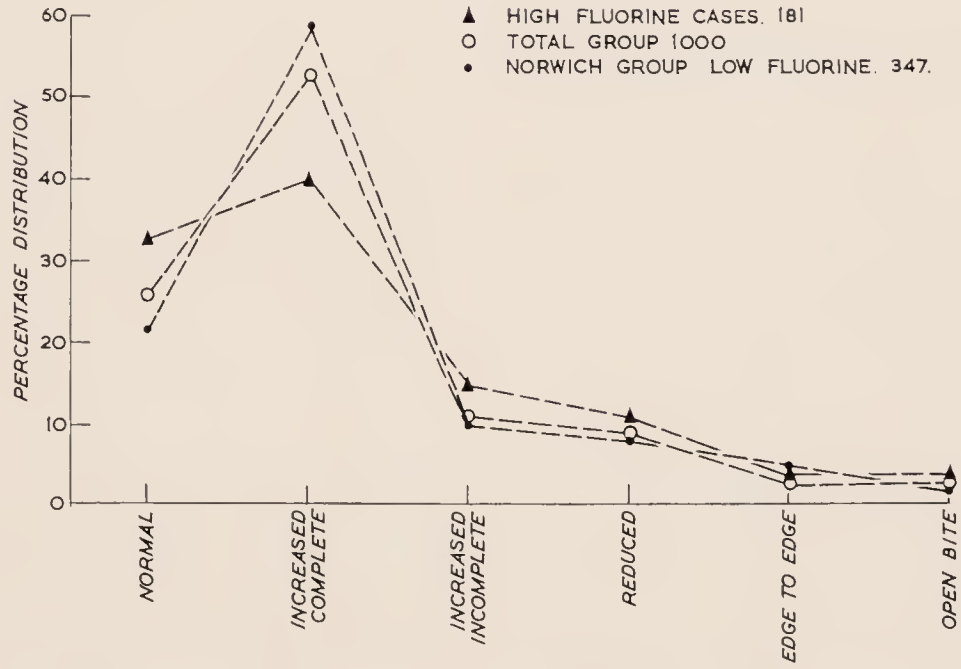


*Fig.* 13.—Various degrees of overbite of high and low fluorine groups compared.

the skeletal pattern. The percentage distribution of the tooth-apart type of swallow was lower in the low fluorine group, but when present with a tongue thrust it was higher.

The percentage distribution of upper incisors with a normal axial inclination was higher in the fluorine group but fractures of upper incisors were lower. The same applied to the lower incisors, but to a lesser extent.

below of the gingivæ round the upper and lower incisors, was much higher in the continuous fluorine group. As with caries, the average P.M.A. cases, i.e., between 3 and 4 and the high cases of 5 and above, were both much higher in the total group than in the continuous fluorine group. It is interesting how the percentage distribution of cases with good oral hygiene is higher in the continuous fluorine group, at the expense of the average and poor cases.

In *Fig.* 12 it will be noticed that the percentage of the various types of overjet was extraordinarily similar in the 3 groups, as would be expected seeing that the definite Skeletal II and definite Skeletal III dental bases are not affected; in *Fig.* 13, on the other hand, the percentage distribution of the definite Skeletal II cases are not significantly affectcd.

**Moderately High (Highish) Frankfort–Mandibular-plane Angles.**—It is interesting how the definite Skeletal III percentage has dropped to below average whilst the mild Skeletal III percentage remains up. The same

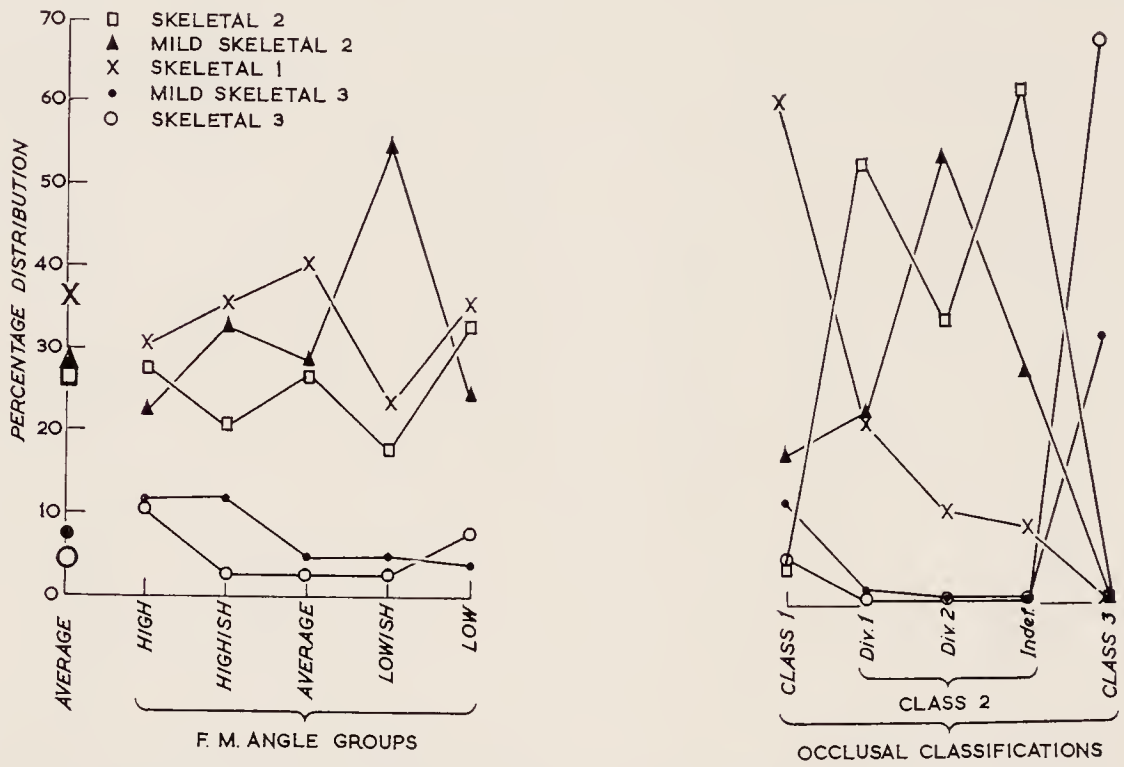


*Fig.* 14.—The different dental base relationships in various Frankfort–mandibular-plane angle and occlusal groups compared.

various types of overbite varies considerably. The percentage of cases with normal and increased incomplete overbite was higher in the continuous fluorine group, but the percentage of increased complete overbite cases was much lower. This again is probably due to the relative increase in the Skeletal I cases in the continuous fluorine group.

In *Fig.* 14 the percentage distribution of the various skeletal groups is plotted against the Frankfort–mandibular-plane angles and Angle's occlusal classifications. It is probably clearer to take the various Frankfort–mandibular-plane angles and occlusal groups individually and compare the various skelctal percentage distributions against the average for the various groups. The percentage distribution of the various skeletal classes in the total group can be seen in the first column.

**High Frankfort–Mandibular-plane Angles.**—This is up in both the Skeletal III and mild Skeletal III groups, as would be expected. There is, therefore, a drop in the percentage of Skeletal I and mild Skeletal II cases. The distribution is found with the definite Skeletal II and mild Skeletal II cases, whilst the Skeletal I distribution is average. In other words, there is a general improvement of the skeletal pattern.

**Average Frankfort-Mandibular-plane Angles.**—Here, as would be expected, the percentage distribution is higher amongst the Skeletal I cases, about average for the Skeletal II and mild Skeletal II, and slightly lower for Skeletal III and mild Skeletal III ones.

**Moderately Low (Lowish) Frankfort–Mandibular-plane Angles.**—Here the percentage distribution of the mild Skeletal II cases is very much higher than that for the total group. All the other skeletal groups are, therefore, depressed. This is probably the reason why a lowish Frankfort–mandibular-plane angle is so often found in Class II, division 2 cases.

**Low Frankfort-Mandibular-plane Angles.**—Here the percentage distribution of Skeletal I cases is about the same as for the total group. It is, however, higher for the definite Skeletal

II and Skeletal III eases. but is slightly lower for the mild II and mild III eases. This is interesting, beeause it shows the group of Skeletal III eases with a low Frankfort–mandibular-plane angle. Also elinieally quite a number of gross Skeletal II cases have a low Frankfort–mandibular-plane angle.

## OCCLUSION

**Class I.**—As was expeeted, the pereentage distribution of the Skeletal I eases was mueh higher than that for the total group. The distribution of mild Skeletal II was lower, and for definite Skeletal II eases lower still. On the other hand, the distribution of mild Skeletal III was up, whilst that of the definite Skeletal III was about normal.

It would seem, therefore, that the prognosis for a Class I oeclusion is mueh more favourable if there is a Skeletal I or mild Skeletal III dental base. Should the skeletal pattern tend towards a Skeletal II, then prognosis is eomparatively poor.

**Class II, division 1.**—Here the definite Skeletal II distribution is mueh higher, showing how important an aetiologieal faetor this is, either on its own aeeount or in influeneing an abnormal lip morphology and behaviour. The pereentage distribution of mild Skeletal II eases is slightly below the total group, whieh is interesting, whilst that of the Skeletal I eases is definitely low, and mild Skeletal III and Skeletal III almost non-existent.

**Class II, division 2.**—Here it is interesting how the mild Skeletal II pereentage distribution goes right up whilst the definite Skeletal II drops, but is still higher than that for the total group. The Skeletal III groups are very low or even non-existent.

**Indefinite Class II.**—These are the eases whieh would not fit into either division 1 or division 2. Here the definite Skeletal II dental base distribution is mueh higher and would seem to be a mueh more important factor.

**Class III.**—As one would expect, the Skeletal III and mild Skeletal III eases have a mueh higher distribution, whilst the others are non-existent.

## NORMAL LIP MORPHOLOGY AND BEHAVIOUR

As already explained, this group ineluded some competent and some slightly ineom-petent eases. Only 18 per eent of eases were assessed as absolutely normal in both morphology and behaviour. Perhaps we were too striet in our assessment of normal.

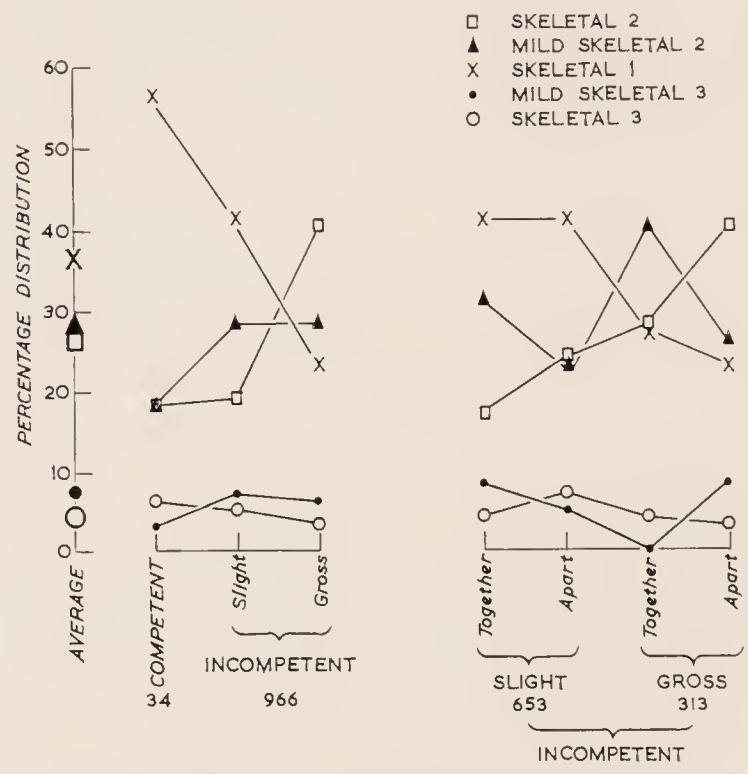


*Fig.* 15.—Dental base relationships of various lip morphologies compared.

*Fig.* 15 shows the dental base relationship plotted against the soft-tissue morphology.

**Competent Lips.**—In *Fig.* 15 the pereentage distribution of both definite Skeletal II and mild Skeletal II eases is well down, whilst that for the Skeletal I group is well up.

**Incompetent Lips.**—The numbers of eases whieh fell into this group by definition were extremely large, consisting of 966 eases out of the 1000. The distribution was, therefore, almost identieal to the total group. They were subdivided into slight and gross and whether usually together or apart.

**Slightly Incompetent Lips.**—Here the pereentage distribution of the definite Skeletal II eases is still below the average for the total group, but that of the Skeletal I group is slightly up, but not as high as for the eompetent lips. The mild Skeletal II group has also gone up to average.

**Grossly Incompetent Lips.**—In eontrast to the previous group, it will be noticed that the pereentage distribution of the definite Skeletal

II cases is very much higher, whilst that of the Skeletal I cases is very much down. The other skeletal groups do not differ very much. When these last two groups were subdivided again into whether the lips were usually together or apart, the main point of interest was the different percentage distribution of the definite Skeletal II cases. These were much higher in both groups when the lips were usually held apart, at the expense of the mild Skeletal II cases, which was much higher in both groups when the lips were together.

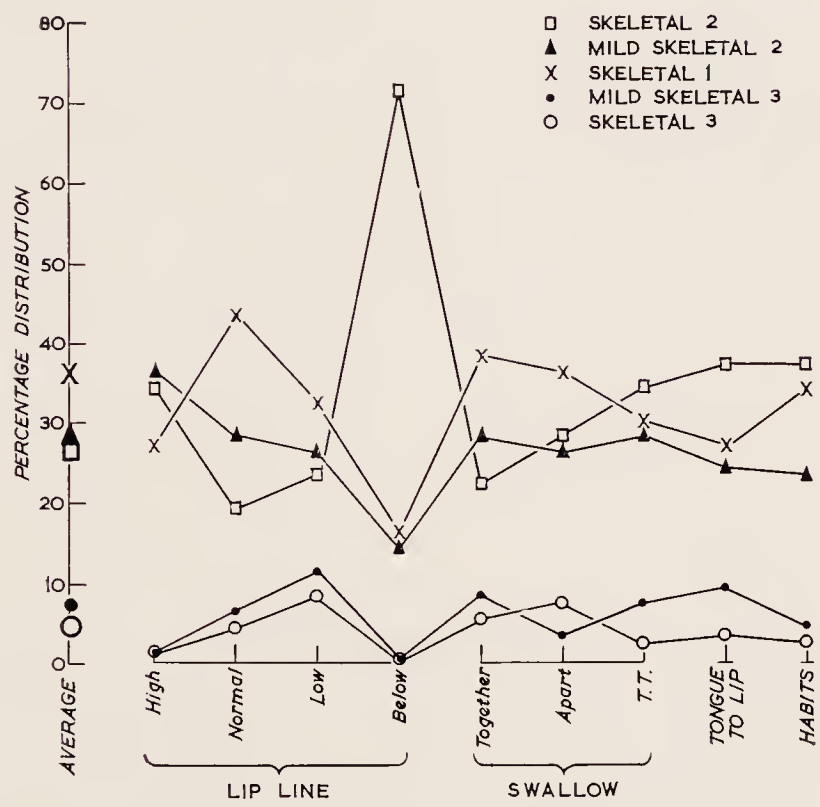


*Fig.* 16.—Dental base relationships of various lip morphologies and swallowing behaviours compared.

In those cases where the lips were separated by 21|12, the definite Skeletal II distribution was extremely high at over 70 per cent, as would be expected.

There would, therefore, appear to be a very close correlation between a definite Skeletal II dental base relationship and the soft-tissue morphology.

*Fig.* 16 shows the dental base relationship plotted against the position of the lip line and the type of swallowing activity.

*Lip Line High, that is to say, above Occlusal Half of the Crown of the Upper Incisor.*—One hundred and forty-three cases fell into this category—14·3 per cent. It will be noticed that the percentage distribution of both the definite Skeletal II and mild Skeletal II cases is much higher than the total group, whilst that of Skeletal I and the two Skeletal III groups is lower. It will be remembered that the percentage distribution of low and lowish Frankfort–mandibular-plane angles is higher in the two Skeletal II groups, so this may account for the distribution found.

*Lip Line Normal, that is to say, over the Occlusal Half of the Crown of the Upper Incisors.*—Four hundred and ninety-one cases come into this group—49·1 per cent. It will be seen that the percentage distribution of the definite Skeletal II cases has fallen well below the total group, whilst that for the Skeletal I cases has risen higher. The two Skeletal III groups and the mild Skeletal II cases are about the same as the total group.

*Lip Line Low, that is to say, over the Upper Incisor Tips.*—Three hundred and eight cases fell into this group—30·8 per cent. The alteration here is that the percentage distribution of the two Skeletal III groups has risen to above that for the total group, whilst that of the Skeletal I cases has fallen.

*Lip Line below the Upper Incisors.*—Only 58 cases fell into this group—5·8 per cent. It will be noticed how the percentage distribution of the definite Skeletal II cases has risen right up to over 70 per cent, whilst that for all the other groups has dropped very low.

The percentage distribution of the various skeletal group are now plotted against the types of swallowing behaviour, tongue thrust, and tongue positions.

*Swallowing Behaviour with Buccal Teeth together and no Evidence of an Anterior Tongue Thrust.*—Five hundred and seventeen cases fell into this group—51·7 per cent. It will be noticed that the percentage distribution of the various skeletal groups is slightly more favourable than for the total group, in that the Skeletal I cases is slightly higher, whilst that of the definite Skeletal II is lower. This alteration is so slight as not to be significant, which is rather interesting.

*Swallowing Behaviour with Buccal Teeth apart and no Anterior Tongue Thrust.*—One hundred and fifty-seven cases came into this group—15·7 per cent. It will be noticed that the percentage distribution in these cases is rather similar to the previous tooth-together

group except that for the definite Skeletal II and definite Skeletal III cases it is slightly higher.

*Swallowing Behaviour with Buccal Teeth apart and with some Degree of Anterior Tongue Thrust.*—Here the percentage distribution of the definite Skeletal II cases has increased even more at the expense of Skeletal I and definite Skeletal III.

*Swallowing Behaviour with Buccal Teeth together and with some Degree of Anterior Tongue Thrust.*—There were only 4 cases out of the total 1000 which came into this group. It was difficult to say whether there was an actual tongue thrust, or whether the tongue was just coming forward through the gap. One of these had a mild Skeletal III dental base, whilst the other 3 were Skeletal I.

There were 32 cases in which the swallowing behaviour was so doubtful and indefinite that they could not be put into any of the other groups. In these cases the percentage distribution of the definite Skeletal II cases was considerably below the total group, at the expense of the mild Skeletal III cases in which it was much higher.

*Tongue Position between the Incisor Teeth at Rest.*—One hundred and sixty-nine cases fell into this group—16·9 per cent. In this group the percentage distribution of the definite Skeletal II cases was even higher, about 37 per cent.

There is here, therefore, some further evidence of a correlation between a definite Skeletal II dental base and abnormal soft-tissue morphology and behaviour.

The percentage distribution of the various skeletal groups was also plotted against the presence and duration of sucking habits. The main variation from the total group was a significant rise in the percentage distribution of the definite Skeletal II cases in those where sucking habits persisted over the age of 9 years.

## OVERJET

*Fig.* 17 shows the percentage distribution of the various skeletal groups plotted against the different types of overjet.

**Normal Overjet.**—Five hundred and fourteen cases came into this category—51·4 per cent. Here, as would be expected, the percentage distribution of the Skeletal I and the mild Skeletal III cases is higher than that for the total group. For the mild Skeletal II and the definite Skeletal III cases it is about the same, whilst that of the definite Skeletal II group is much lower.

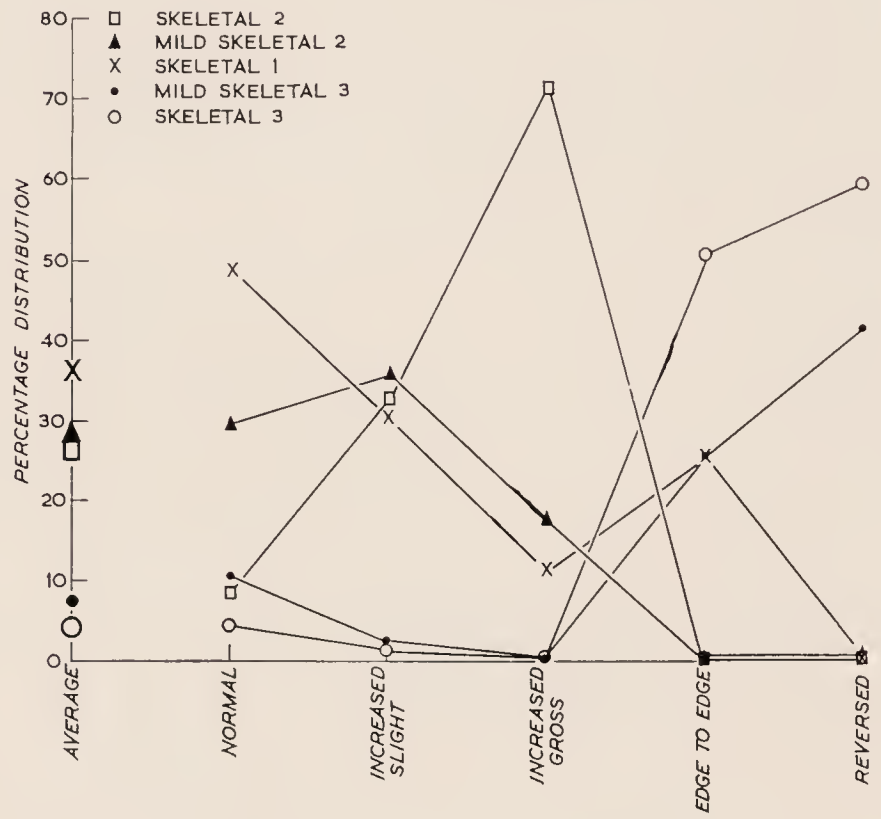


*Fig.* 17.—Dental base relationships of various types of overjet compared.

**Slight Increase in Overjet.**—Two hundred and seventy-six cases came into this category—27·6 per cent. These were the cases which had an increase in overjet, but which was less than 3 mm. Here the percentage distribution of the mild Skeletal II and definite Skeletal II cases has gone up at the expense of the Skeletal I and both the Skeletal III groups, in which it has gone down to below the average.

**Gross Increase in Overjet.**—The overjet is more than 3 mm. in these cases. One hundred and seventy-three cases came into this category—17·3 per cent. Here the percentage distribution of definite Skeletal II cases is very high at 72·5 per cent, whilst for the mild Skeletal II and Skeletal I cases it is much lower than average and both the Skeletal III groups are non-existent.

**Reverse Overjet.**—Only 17 cases came into this category—1·7 per cent. As would be expected, both the Skeletal III and mild

Skeletal III groups are much higher than average, whilst all the other groups are non-existent.

**Edge-to-edge Overjet.**—Only 20 cases came into this category—2 per cent. Here the Skeletal I group came into the picture slightly, otherwise the distribution is much the same as for reverse overjet.

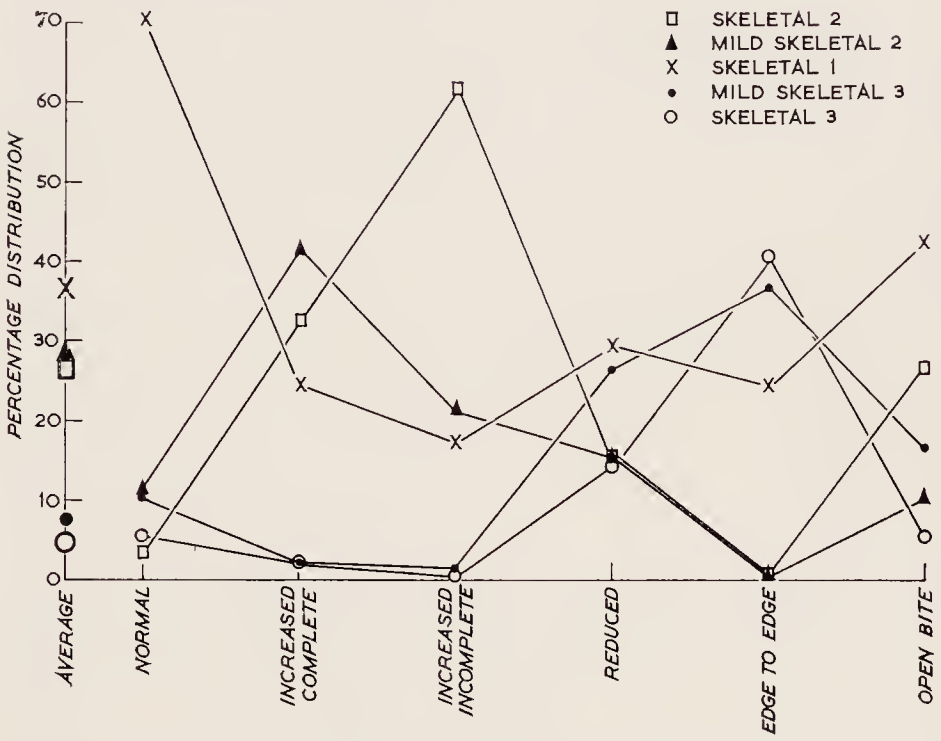


*Fig.* 18.—Various dental base relationships of different types of overbite compared.

## OVERBITE

*Fig.* 18 shows the percentage distribution of the various dental base relationships in the different groups of overbite compared.

The mild Skeletal III group was also slightly up, whilst the Skeletal III cases was about normal, and the mild Skeletal II and definite Skeletal II groups very low.

The mild Skeletal III group is up, probably because of a compensating retroclination of the lower incisors, due, often, to a normal muscle environment.

**Increased Complete Overbite.**—This was found in as many as 525 cases, i.e., 52·5 per cent. Both the definite Skeletal II and mild Skeletal II cases were higher than the total group at the expense of the Skeletal I cases. The mild Skeletal III and Skeletal III groups were slightly down.

**Increased Incomplete Overbite.**—These were the cases where the overbite was increased, but in which the lower incisors did not make contact with either the upper incisors or palate. One hundred and fifty cases came into this group—15 per cent.

It is interesting how very high the percentage distribution of definite Skeletal II cases is at about 60 per cent. All the other groups were depressed, especially both the Skeletal III groups which were almost non-existent. You will remember that the percentage distribution of definite Skeletal II cases was high at 37 per cent in the group that had a tongue-to-lower-lip tongue position.

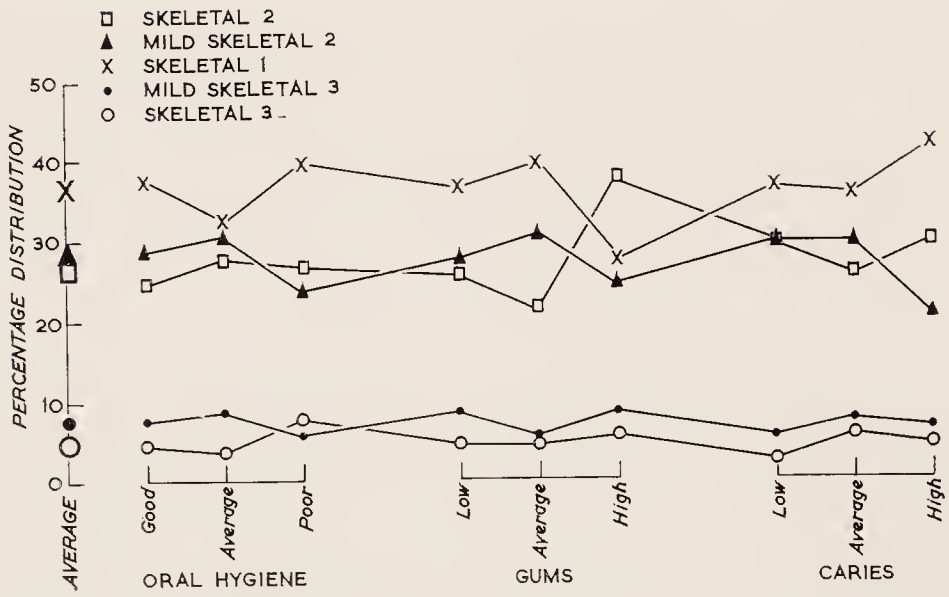


*Fig.* 19.—Dental base relationships in various degrees of oral hygiene, gums P.M.A., caries D.M.F.

**Normal Overbite.**—Two hundred and fifty-three cases came into this category—25·3 per cent. Here the percentage distribution of the Skeletal I cases was very high at 70 per cent. There is probably an association here for this very high Skeletal II percentage.

**Reduced Overbite.**—Seventy-eight cases fell into this group—7·8 per cent. Again, it is

interesting that the percentage distribution of the mild Skeletal III and definite Skeletal III cases is considerably up at the expense of the mild Skeletal II and definite Skeletal II groups, whilst for the Skeletal I cases it is about average.

It would, therefore, appear that in this group both the Skeletal III dental base relationships with their associated tendency to have high or highish Frankfort–mandibular-plane angles play a considerable part in the aetiology.

**Edge-to-edge Overbite.**—Only 25 cases fell into this group. Here the percentage distribution of mild Skeletal III and definite Skeletal III cases is even higher, whilst both the Skeletal II groups are non-existent. Here, again, the skeletal pattern is playing the major part in the aetiology.

**Anterior Open Bite.**—Only 19 cases fell into this group. Here, as would be expected, a mixture of muscle behaviour and skeletal form is seen as the aetiological factor.

The percentage distribution of mild Skeletal III and definite Skeletal III cases is higher than average, but not to the same extent as in the previous two groups. For the Skeletal I and definite Skeletal II cases it is also up, but not as much, whilst the mild Skeletal II group is low.

*Fig.* 19 shows the percentage distribution of the various skeletal classifications in the different oral hygiene, P.M.A., and D.M.F. groups compared.

The main point to notice is the rise in the distribution of definite Skeletal II cases in the high P.M.A. (bad gums) group.

I have only had time in this paper to show you the percentage distribution of the various skeletal groups plotted against a few of the other factors collected during our clinical examination. But it has, I think, shown the importance of dental base relationship in the aetiology of occlusion. I have continued this analysis by plotting the various other factors against each other with some very interesting results.

Finally, I thought it would be rather interesting just to see how many moderately ideal occlusions I could find in these 1000 children. *Table I* shows the way I extracted them. You will notice that there were only 36, i.e., 3·6 per cent.

I have analysed these 36 cases and would like to draw your attention to just one of the features on account of the recent correspondence in the *British Dental Journal.* This was the fact that 8 of them had persistent sucking habits which lasted beyond the age of 9 years, i.e., 22 per cent as against 13·7 per cent for the total group. This is interestingly high, but it must not be forgotten that the group only consisted of 36 cases. From the analysis of the total 1000 cases, persistent sucking-habits as with abnormal muscle behaviours are statistically much more common in patients with a definite Skeletal II dental base relationship, but are then usually associated with an abnormal muscle activity.

*Table I.*—Data derived from the Powers-Samas Sorter giving Details of Moderately Ideal Occlusions with Variations found in the 1000 Children

| | |
|---|---|
| Occlusal Class I | 440 |
| Overbite normal | 235 |
| Overjet normal | 227 |
| No upper incisor crowding | 132 |
| No upper incisor spacing | 106 |
| No upper incisor rotations | 106 |
| No upper incisor diastema | 106 |
| No upper incisor local abnormalities | 104 |
| No lower incisor crowding | 77 |
| No lower incisor spacing | 76 |
| No maxillary buccal segment crowding | 66 |
| No mandibular buccal segment crowding | 64 |
| Upper incisors normal axial inclination | 54 |
| Lower incisors normal axial inclination | 51 |
| Skeletal Class I | 47 |
| Average Frankfort–mandibular angle | 36 |

**Acknowledgements.**—I would like to thank the other members of our team, Mr. P. M. C. James, Mr. D. A. Plint, and Mrs. A. D. Valentine, for all their hard work in collecting this material, and those in charge of the various schools we visited for their hospitality and general help, and the Directors of Messrs. Hedley & Sons for their very generous grant which made this research possible.

I would also like to thank Mr. J. H. Hovell for his helpful suggestions; Mrs. MacKenzie for her radiograph tracings and help in assessing the degree of my clinical accuracy; Mr.

Ready and Miss Sheila Bates of the Records Department, The Hospital for Sick Children, Great Ormond Street, who punched the Powers-Samas cards for me and extracted all this material; Mr. J. Shilland, of the Photographic Department of the Royal Dental Hospital, for the illustrations; and last, but not least, my secretary, Miss B. M. Horton, for working out the percentages, making up all the graphs, and generally helping me with this paper.

*Mr. G. C. Dickson*, in thanking the President on behalf of all present, said that it was the custom of the Society not to invite discussion of the Presidential Address unless that was the specific wish of the President. The customary discussion was replaced by a vote of thanks.

He had been told that there were two reasons for this: first, it gave the President the only opportunity that he was likely to have of making outrageous statements unchallenged; second, it absolved the proposer of the vote of thanks from the necessity to remain awake during the delivery of the paper. He was certain that neither of these conditions applied tonight, though Mr. Walther had slipped in one or two remarks that might have been torn apart by the wolves if opportunity had offered! He was himself looking forward to getting Mr. Walther on his own and asking him a few questions.

A paper of such standing demanded from its author a great deal of work. For the benefit of those who did not already know it, he would mention that the President was Reader in Orthodontics at the Royal Dental Hospital and the Hospital for Sick Children at Great Ormond Street. He was also Secretary of the European Orthodontists Society, which was to meet in Belfast in July. Despite all these interests he had found time not only to collect the informative statistics with which they had been presented, but to settle down and work them out.

He would like to thank him most heartily, on behalf of everyone present, for his extremely interesting address, and to wish him well in his Presidency during 1960.

# BITING AND MASTICATION*

## A CINÉRADIOGRAPHIC STUDY

By **G. M. ARDRAN**, M,A., M.D., M.R.C.P., D.M.R.
and **F. H. KEMP**, M.A., F.R.C.P., D.M.R.

Our interest in these problems began when we studied the funetional stability of artifieial dentures with Munz (Ardran, Kemp, and Munz, 1957) and biting and mastieation in the domestie rabbit with Ride (Ardran, Kemp, and Ride, 1958).

### RABBIT

When the rabbit was sitting at rest, a lateral X-ray showed that the lips were separated by a thin airspaee whieh eommunieated with a small poeket of air in whieh were the cutting edges of the ineisor teeth. The edges of the lower incisor teeth lay behind the edges of the upper anterior ineisors in eontaet with, or only slightly separated from, a small pair of posterior upper incisors. The premolars and molars (the eheek teeth) were positioned so that the transverse ridges of the maxillary teeth were in line with the valleys on the mandibular teeth. The ventral surfaee of the soft palate was opposed to the arehed dorsal surfaee of the tongue with the uvula just above the epiglottis. In dorsoventral projeetion, the lower jaw was symmetrieally plaeed about the mid-sagittal plane: the mandibular teeth were nearer the midline than the maxillary teeth by nearly one mandibular tooth width anteriorly, and slightly less than this posteriorly.

**Biting.**—Fresh green-stuff was eropped by taking it into the mouth and eutting it between the incisors: no loose ends were left projecting from the mouth. Older and drier material was detaehed by pulling. Long grass was eut with the ineisors by a point along the stem and then transferred to the side of the mouth. Lateral einéradiographs showed that when a biting movement began the mandible was lowered and moved forward so that on closure of the mouth the lower and first upper ineisors met edge to edge: then the lower ineisors usually slid behind the upper ineisors, the mandible returning to the rest position at the end of the biting sequenee. Soft materials were severed by apposition of the ineisors edge to edge: the sliding movement of the lower ineisors upon the wear surfaee of the upper incisors appeared neeessary for eutting tough material.

When the mouth opened to bite, the tip of the tongue remained elose to the posterior surface of the lower ineisor teeth. As the food was taken into the mouth the forepart of the tongue was moved slightly baekwards and lowered from the hard palate. As the mouth elosed on the material, the tip of the tongue was thrust forwards beneath the pieee whieh was to be bitten off.

*The Transport of the Bite to the Cheek Teeth.*—The incisor teeth of the rabbit are separated from the eheek teeth by a wide gap ealled the long diastema. When the rabbit had bitten off a pieee of food, it usually eommeneed to make jaw movements of the ehewing eycle. As the mouth opened the tongue was slightly retraeted and the pieee of food (the bite OED) resting upon it was earried baekwards. As the mouth closed the bite was pressed against the ridges of the hard palate and was held in position as the tongue again moved forwards. From two to four eyeles of jaw movement were usually required to transport the bite from the front of the mouth to the anterior premolar teeth. The dorsoventral projeetion showed that the bite was transported baekwards over the surfaee of the tongue on the side on whieh chewing would take plaee. When the leading edge of a piece of rabbit-eake approached the anterior premolars, the trailing edge was tilted upwards by the tongue towards the hard palate so that the leading edge was brought down on to the grinding surfaee of one or more

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* This paper is part of a communication given before the Society. The first section relating to infant feeding was an abstract of the work already published (*see* Additional References, p. 28).

Given at the meeting held on February 8, 1960.

of the anterior cheek teeth. Lengths of herbage were held in the diastemal region by the tongue and protruded from the mouth lateral to the lower incisor teeth and were passed backwards towards the premolar teeth on the same side. As the animal chewed, the posterior end of the stalk moved backwards as the mouth opened and was sometimes moved a little forwards as the mouth closed: the effective rate of inward movement seemed to depend on the toughness of the material.

**Chewing.**—The jaws were closed at the beginning and end of each chewing cycle. As the jaws began to open, the mandible moved forwards, as it did in biting: the midline of the mandible was lowered in the mid-sagittal plane. As the jaws began to close, the mandible moved outwards a little more than the width of one tooth, so that when the jaws closed the outer (buccal) edges of the mandibular cheek teeth were beneath the buccal edges of the maxillary cheek teeth of that side. As the mandible returned to the position of rest, the mandibular cheek teeth moved across the surface of the maxillary cheek teeth, thus crushing the food: this is the grinding phase of chewing.

**Tongue Movements.**—When the animal was chewing the tongue made a number of different movements. There were the movements, which have been described, which were concerned with transporting the bite backwards towards the cheek teeth; the movements of the forepart of the tongue which were concerned with positioning the bite upon the premolars on the side on which chewing occurred; the movements in the region of the cheek teeth which were responsible for the transport of the crushed material backwards and its replacement upon more posterior cheek teeth before grinding took place; the movements of the tongue which were concerned with the storage of food material between the soft palate and tongue before swallowing; and finally the movements of the tongue associated with swallowing. All these movements could take place without interrupting chewing.

The material which was crushed or detached in the first chewing movement was displaced medially on to the tongue during this phase, and as the jaws opened for the next cycle the crushed material on the tongue was moved backwards. When the jaws re-opened in the next cycle, the chewed material was replaced on the teeth in a more posterior position. After a series of three or four chewing cycles the crushed material reached the posterior teeth, where, with saliva, the particles formed a fluid mass of relatively even consistency, whether of grass or of rabbit-cake. The chewed material as it was passed backwards accumulated between the tongue and the soft palate and gradually descended as a column downwards and medially: as the mass of food accumulated, the soft palate was bulged backwards and the airway was narrowed. In none of the animals examined was there any evidence of the transport of material to the opposite side of the mouth during chewing. All the animals chewed their food thoroughly; there was no evidence that pieces of food were passed backwards. When an adequate amount of chewed material had been accumulated in the back of the mouth it was swallowed; the swallowing motion usually began when the jaws were apposed.

## MAN

**Methods and Materials.**—In some respects man is more difficult to examine than the rabbit. He often seems to have difficulty in behaving naturally, and may show distaste for the contrast medium introduced into his food. The number of radiographic examinations which can be justifiably performed on one volunteer is limited by the dose of X-rays administered. For this report we have studied over 100 unselected adults of different ages, when biting or chewing: not all these individuals had full sets of natural teeth, but all claimed to be able to chew satisfactorily. The examination comprised not more than three 8-second cinéradiographic exposures of each individual: the contrast media used were oatmeal cake containing 50 per cent of barium sulphate powder; a sweet made from barium sulphate and gelatin; and barium-impregnated lengths of liquorice.

Individuals were examined in the lateral, anteroposterior, and dorsoventral projections

when opening and closing the mouth, munching or chewing. Films were also taken of 11 subjects who were asked to make the maximum lateral deviation of the mandible, first with the mouth open and then with the jaws parted just enough to allow this manœuvre to be made; these movements were made with no food in the mouth. In a number of other subjects still X-rays were taken for the purpose of illustration.

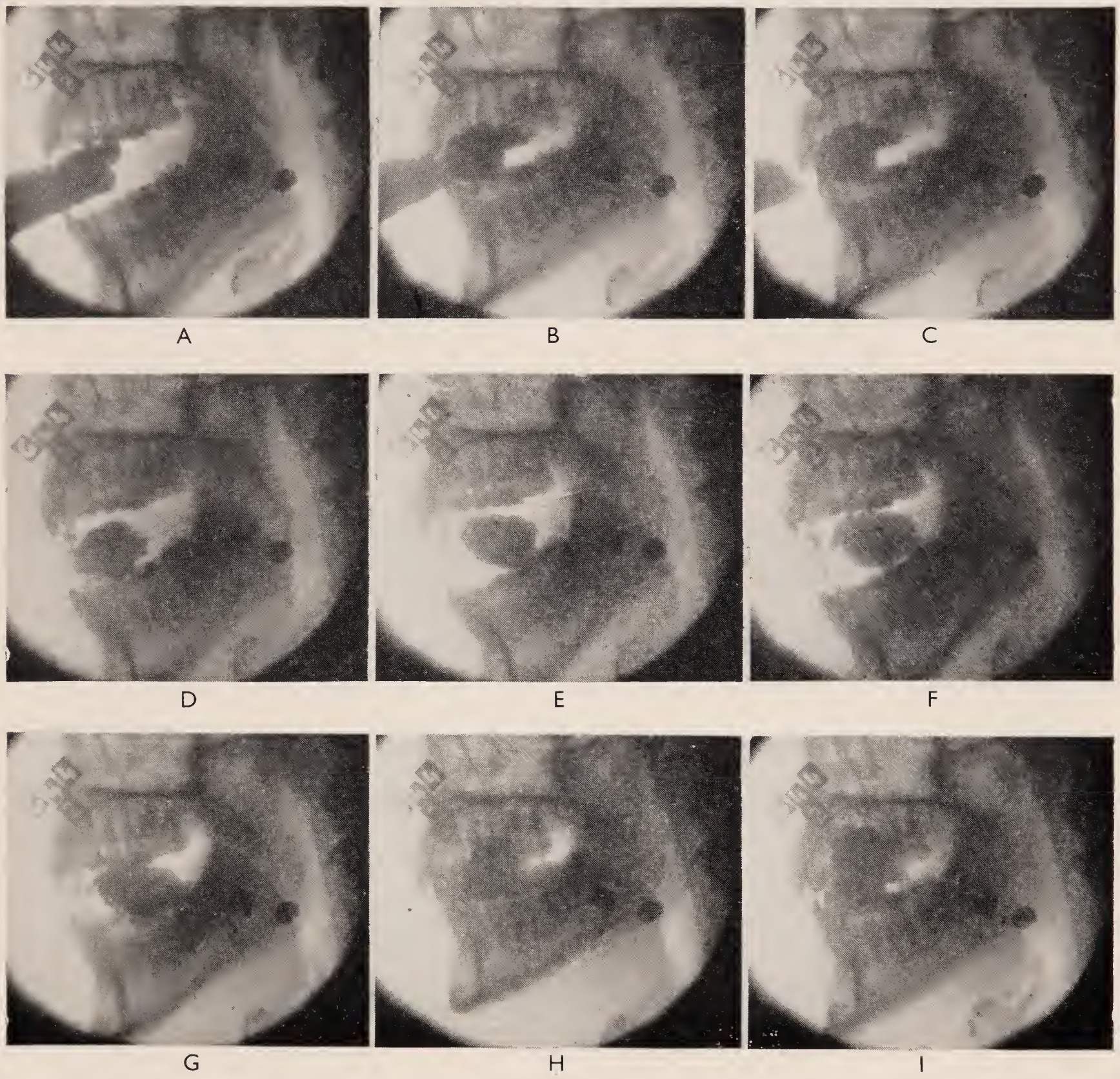
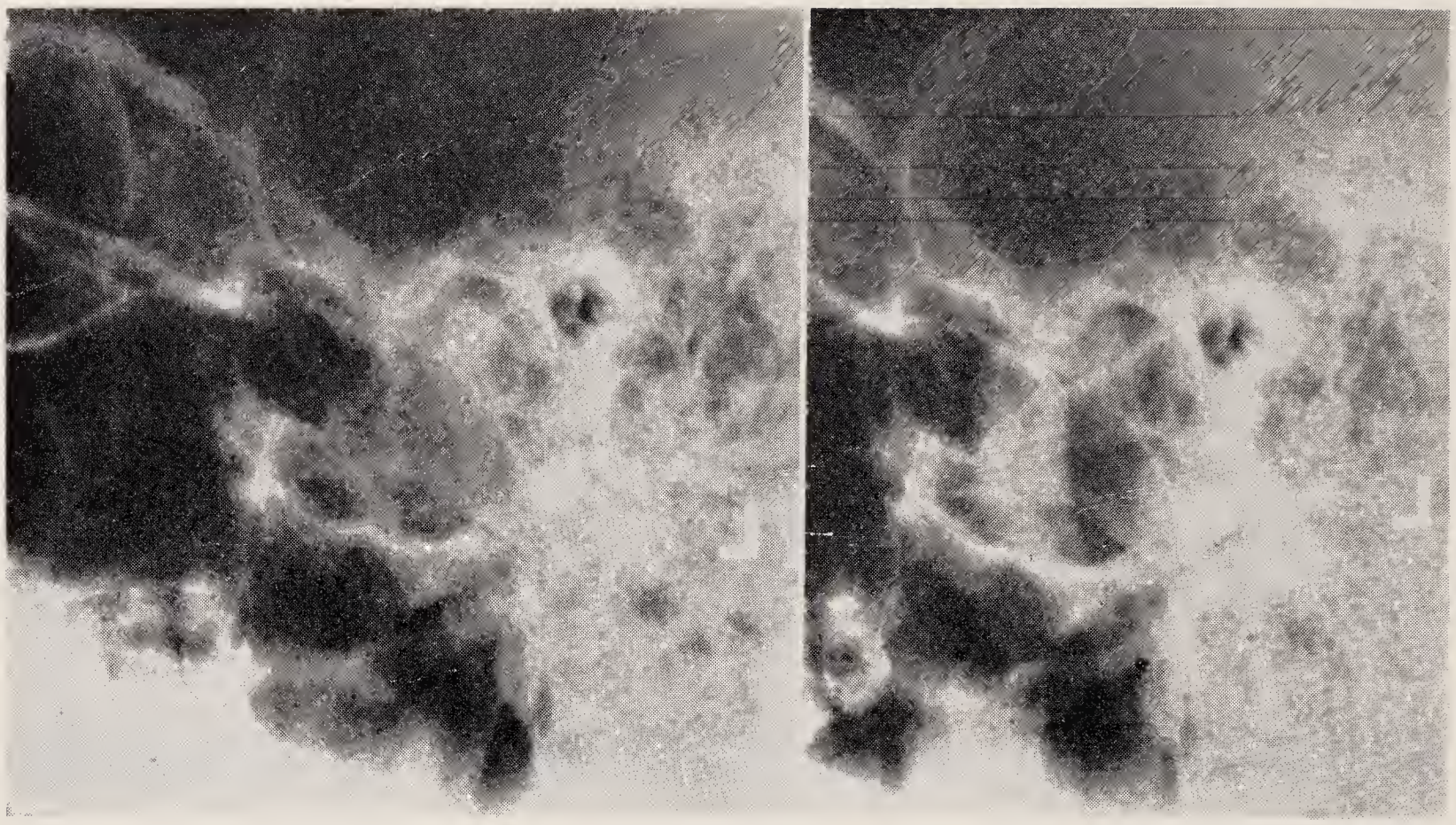



*Fig.* 1.—A series of prints from a cinéradiographic film, taken 25 frames per sec., of an individual taking a bite of a barium-impregnated oatcake.

A, Oatcake held between the teeth. The edges of the incisor teeth are in line: the mandible has been brought forward. The forepart of the tongue is retracted. There is a narrow air-channel between the dorsum of the tongue and the soft palate. B, Eleven frames later. The jaws are closed together: the stick of cake has been broken and the lower jaw has been retruded. C, One frame later. D, Twelve frames later. Mastication beginning. The jaws are parted but the lips are closed (not visible in the print). Oatcake in the forepart of the mouth. Air-space between soft palate widened. E, Three frames later. The lip is raised and the food is beginning to be displaced backwards. F, Three frames later. G, Five frames later. Jaws closing. Food being crushed between the premolar and anterior molar teeth. H, Five frames later. There is still an air-space between the soft palate and the tongue. Practically no food has reached the level of the posterior molars. I, Seven frames later. Jaws opening for next munch or chew.

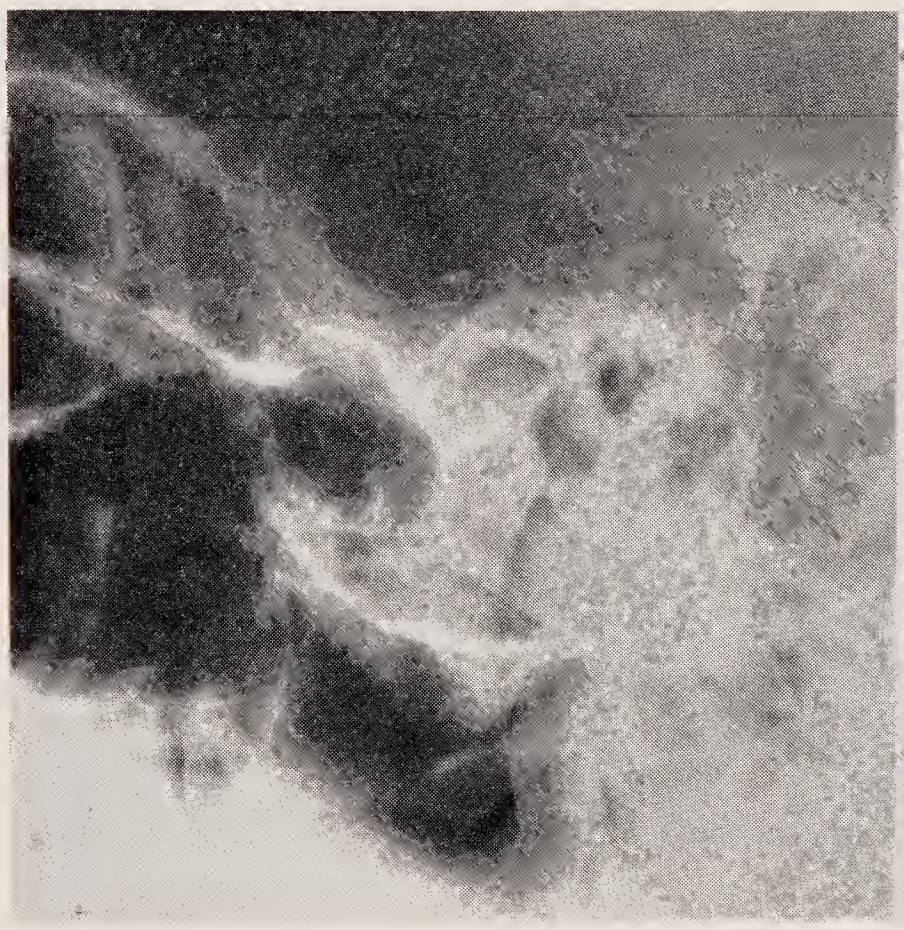
It was established from an anteroposterior projection that the food mass was situated on the right side of the mouth. The two black opacities overlying the angles of the mandible were markers fixed to the skin: they do not indicate the movements of the mandible.



A



B



C

D

*Fig.* 2.—Still radiographs of the temporomandibular joints of a young adult taken from the side with the X-ray beam angled caudally 25° so that one joint is projected in line above the other. Difference between the two sides due to variations in magnification.

A, Mouth closed. Condyles lie behind the articular eminences. B, Mouth open. Condyles have both moved forward equally, and are now beneath and slightly in front of the articular eminences. C, Mouth opened just enough to allow the lower jaw to deviate to the right. The left condyle (the top one and that which was close to the film) has moved downwards and forwards beneath the eminences, whereas the right condyle (the lower one) has rotated but not moved forwards or backwards. D, Mouth open, jaw deviated to the right. The left condyle (top) has moved downwards and forwards beneath the articular eminence. The right condyle (lower) has rotated but has not moved forwards or backwards.

In order to progress from position B to position D the right condyle must pass backwards.

**Biting.**—In the adult at rest the lips were usually closed and the jaws were held slightly apart; the edges of the lower incisor teeth were slightly behind the edges of the upper incisor teeth; the appearances were very similar to the rabbit. When biting, the mandible was moved forwards as the jaw opened and on closure the incisor teeth were apposed edge to edge or with the edge of the lower just behind the upper. Though soft foods such as bread and biscuits were severed or broken easily, tough food appeared to be cut by sliding the chisel edge of the lower incisors backwards upon the upper incisors; these movements are also similar to the rabbit (*Fig.* 1).

As food is introduced into the mouth preparatory to biting, the tongue is retracted from the anterior teeth.

*Mastication.*—The dictionary definitions of mastication, munching and chewing, are not precise; in some respects they are synonymous.

The term "mastication" is best used to cover all those motions which occur in the mouth in the preparation of food for swallowing; these comprise movements of the tongue and jaw to break up the food and mix it with saliva. Food may be softened or dissolved with saliva; incised, squashed between the tongue and palate, or crushed or ground between the teeth. Individuals vary considerably in their habits.

Cinéradiography shows that the teeth may be used in one of two ways, either munching (chopping) or chewing. We use the term "munching" to mean the lowering and raising of the lower jaw upon the upper jaw, whereby the food is incised or crushed between the teeth: this was usually performed mainly by the teeth anterior to the molars. It appeared to be the only method used by persons who have lost their molar teeth, but it was also used by persons whose cheek teeth were intact. We have not seen the rabbit perform munching movements, but they are analogous to biting. Chewing is best defined as the crushing or grinding of food with movement of the mandibular across the maxillary cheek teeth; by analogy with the rabbit (and other similar animals) this action normally takes place on one side only, with a movement of the mandibular cheek teeth across the maxillary cheek teeth from without inwards. In man the form of the jaws is such that the reverse movement takes place on the opposite side, and, if a food mass is large enough to be divided between the two sides, some crushing and grinding will inevitably also take place on this side. Crushing may be defined as the breaking or separating of food by approximation of the teeth with comparatively little shearing force. Grinding is the motion which reduces the food to smaller particles in which a shearing force is more important. Crushing may be made when the mandibular and maxillary teeth are widely separated and the movement may cease before the teeth are closely apposed, whereas in grinding, the mandibular and maxillary teeth are usually not widely spaced and before the movement is terminated they are usually brought close together.

The distinction between munching and chewing is easily made when viewing films taken in the anteroposterior and dorsoventral projections: the deviation of the mandible when chewing can be seen. In the lateral projection, the distinction is more difficult to make and depends mainly upon observations of the movements of the condyle of the mandible and these vary with the width of separation of the jaws.

**Temporomandibular Joints.**—When the mandible was lowered in the midline, the condyles advanced on to the articular eminences and returned as the mandible was raised; the degree of movement depended upon how widely the mouth was opened: the movement was approximately equal on both sides. These movements were seen in munching (*Figs.* 2 and 3).

When the mandible was lowered in the midline as in munching and then the chin was deviated to one side, the condyle on the side opposite the deviation moved farther forwards while the condyle on the side to which the deviation had occurred returned towards the position of rest: both condyles rotated towards the side of the deviation. The deviation resulted in a tilt of the mandible with some approximation of the teeth on the side of the deviation. When the mandible was deviated

with minimal lowering of the jaw, the condyle on the side opposite the deviation movcd forwards to a degree corresponding to the extent of the deviation, whereas the other condyle rotated without any detectable movement backwards or forwards (Munzheimer, 1928). These movements were seen during chewing. During mastication all the above movements were seen in various combinations, and the side to which the chin was deviated was changed from time to time (*Figs.* 2 and 3).

**Chewing.**—Chewing was usually confined to one side at a time; the sequence of movements was very similar to those of the rabbit. The

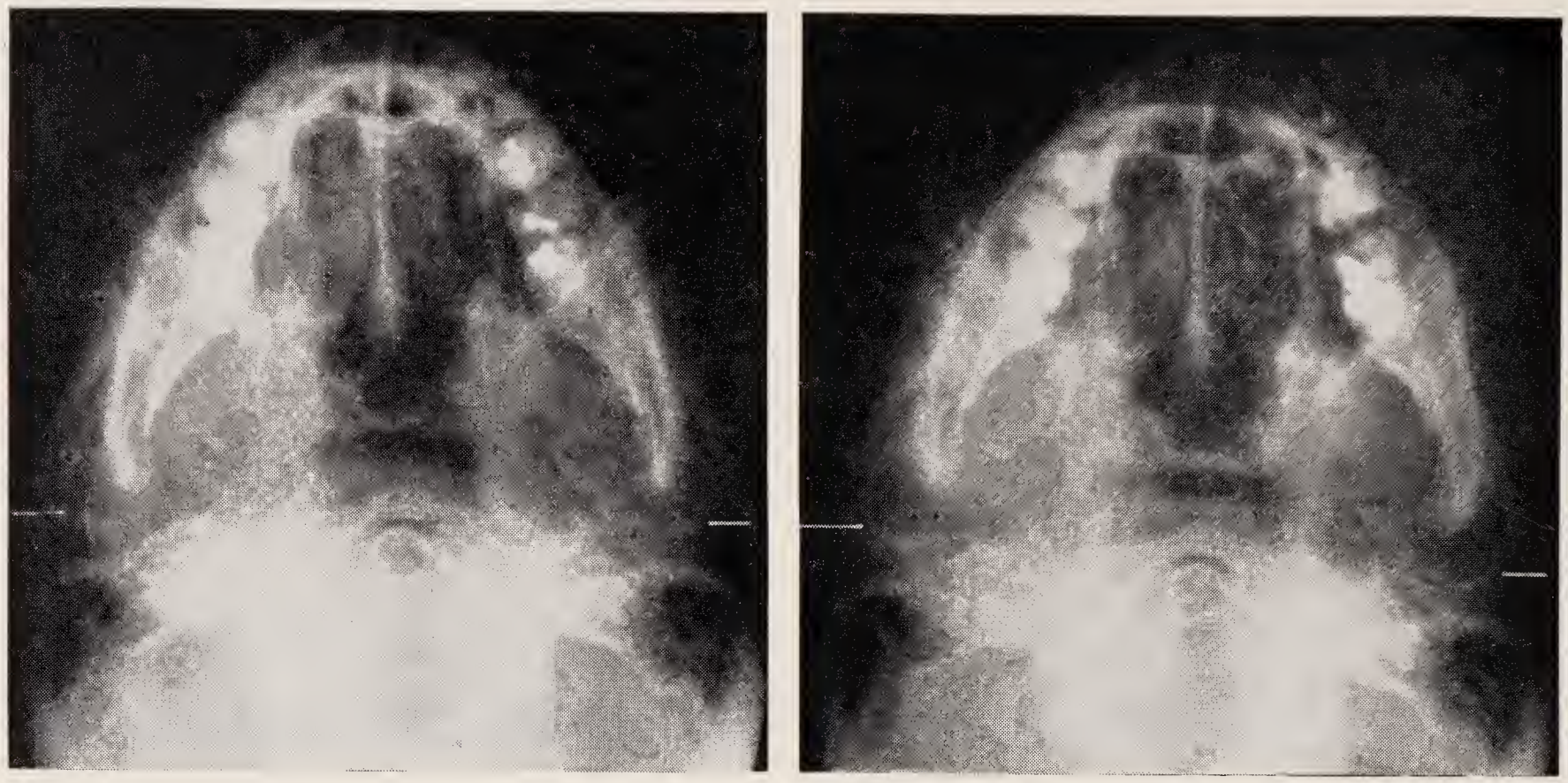



*Fig.* 3.—Ventrodorsal projection of the same individual performing the same movements as *Fig.* 2. In A, C, and D the right condyle remains in a similar position relative to the glenoid fossa and the structures around it (the styloid process is indicated as a fixed landmark): the rotation cannot be easily appreciated in this projection. In B both condyles have moved forwards to the level of the foramina spinosum. In C and D the left condyle has moved forwards (in D more than in C). The rotation of the left condyle can be seen in D.

food was displaced by the forepart of the tongue to the region of the premolar and first molar teeth on the side on which chewing was to take place: the mandible was lowered and moved forward (usually not more than one

there was sometimes sufficient to accumulate between the tongue and the soft palate, as in the rabbit (*Figs.* 4–6). When asked to keep chewing, man chewed as well as the rabbit, but usually he only chewed some of his food. Soft

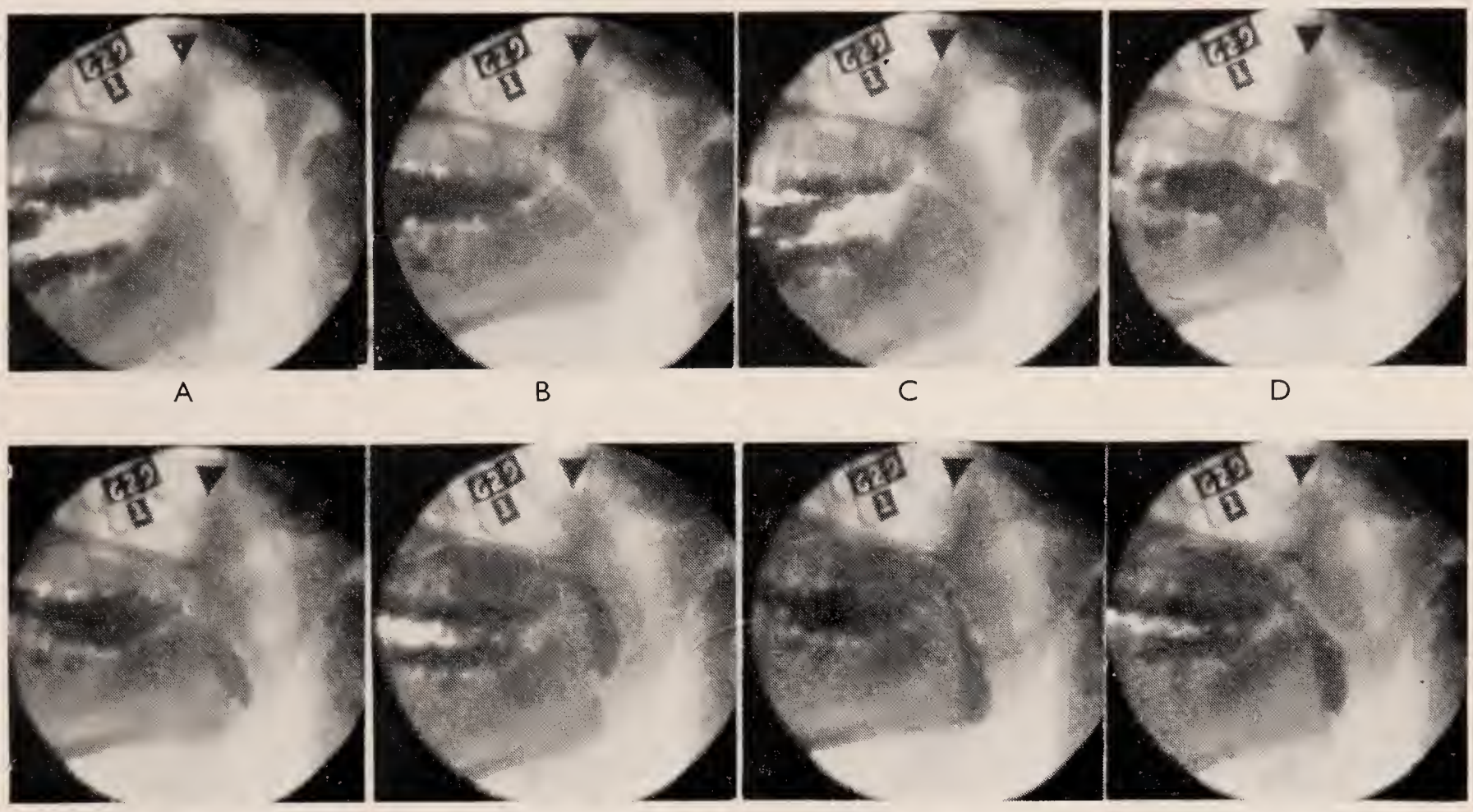



*Fig.* 4.—Selected frames from a lateral cinéradiographic film showing a patient masticating oatcake (25 frames per second).

A, Jaws open. A piece of oatcake has just been taken into the forepart of the mouth. Tongue coated with a little barium taken previously. B, Eight frames later. The conclusion of the first jaw action: the jaws are approximated. A column of air lies between the tongue and the soft palate. C, Seven frames later. Jaws open again. The food still in the forepart of the mouth. D, Thirty-four frames or approximately three jaw actions later. Jaws approximated. Food lies mainly in the region of the premolar and molar teeth, but some has been displaced posteriorly beyond the level of the teeth, between the tongue and the soft palate. Air column between the tongue and soft palate maintained. E, Twelve frames or approximately one jaw action later. A further quantity of food has been displaced backwards by the tongue. Air column between tongue and soft palate maintained. F, Seven frames later. Jaws again open. Tongue raised and food distributed mainly over the side of the tongue. G, Fifteen frames later. Jaws again closed. Some food still distributed over the side of the tongue. Mass of food between soft palate and tongue is now lower. H, Two frames later. Jaws again opening. Further food is being displaced backwards between tongue and soft palate.

Anteroposterior films showed that chewing was taking place on one side only.

third of the maximum opening possible) and then raised and displaced laterally. As the jaws were approximated, the mandible was moved medially towards the position of rest drawing the mandibular cheek teeth in a direction across the surface of the maxillary cheek teeth: the food was crushed and most of it was displaced medially. Most individuals appeared to make several chewing movements for each bite and some of the crushed material was displaced backwards over the side of the tongue on which chewing had taken place; food was reduced to a pulp, but hard food was frequently swallowed in small lumps.

Chewing was mainly confined to the premolars and first molar teeth. The second and third molars were not used very much, indeed some people did not appose these teeth, apparently because of defective growth. Some individuals chewed first on one side and then transferred the food and chewed with the other; the direction of the movement of the mandibular teeth across the maxillary teeth was altered to suit the side on which chewing

was taking place. Nobody regularly altered the side on which chewing was taking place with each successive movement.

The bulk of the food was usually masticated on one side: when some was transferred for a munch. Though chewing proper occurred only on one side at a time, there were some occasions when food was crushed between the teeth on the opposite side as the mandible moved from within out: such food was

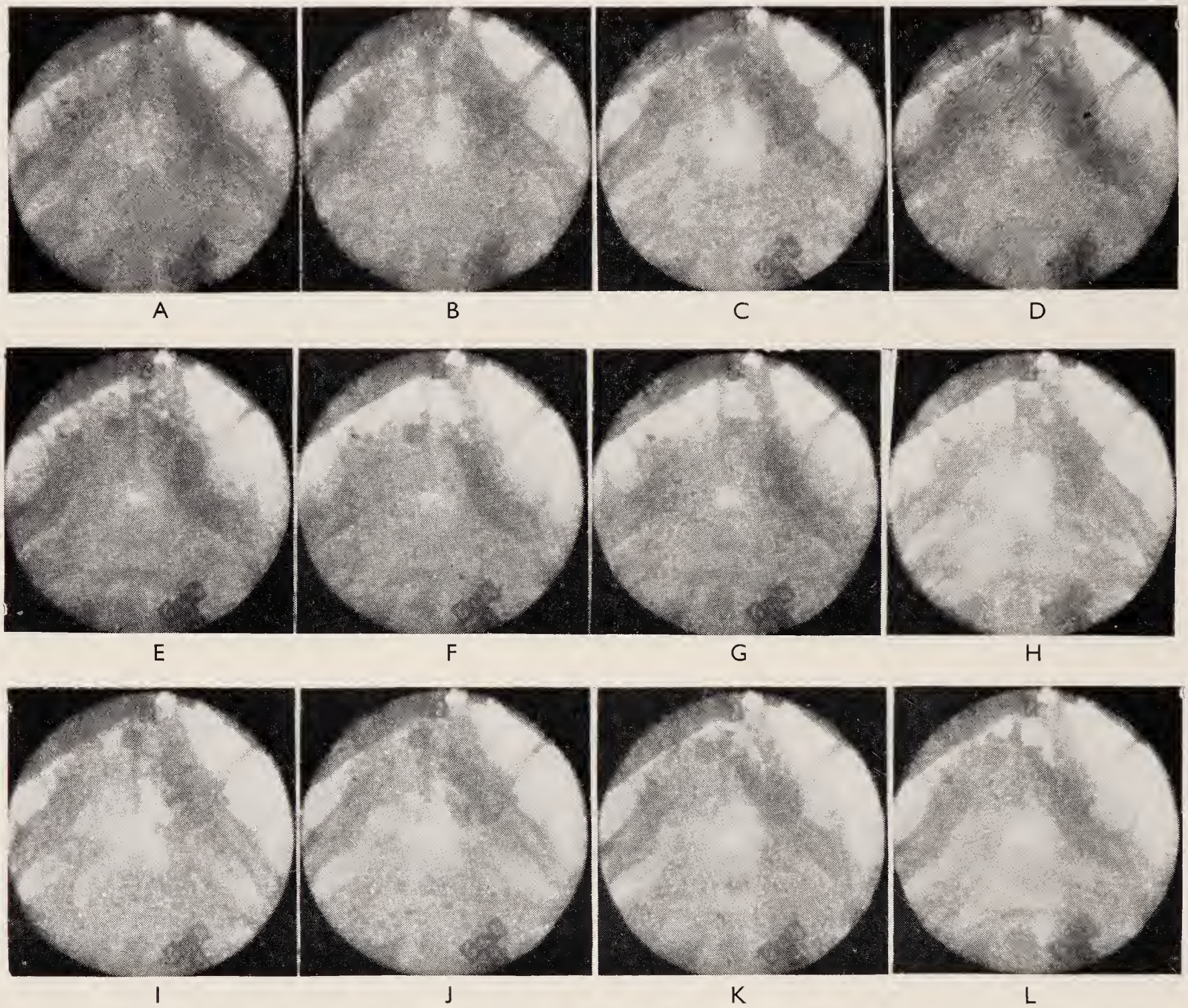



*Fig.* 5.—Selected prints from a cinéradiographic film taken in dorsoventral position (25 frames per second). Patient chewing oatcake. A square marker was placed on the skin over the symphysis menti—this can be seen below the figure 2 at the top of the print. Patient displaced slightly to the left.

A, Mandible deviated slightly to the right; the jaws are closing upon the opaque food. B, Two frames later. The jaws are closed; marker in central position. Food displaced mainly towards the lingual side of the teeth. C, Five frames later. Jaws opening; marker slightly displaced to the left. D, Three frames later. Opening wider. Further displacement of the jaw to the left (Hildebrand movement). E, One frame later. F, Two frames later. Maximum opening of jaws. G, Two frames later. Deviation of the jaw to the chewing side. H, One frame later. Jaw closing. I, One frame later. Jaw closed; marker again central. Food displaced medially. J, Four frames later. K, Two frames later. Jaws again opening (Hildebrand movement). L, One frame later. Further opening with deviation to the left.

chewing on the opposite side, the range of lateral movement of the mandible on this side, in the preparatory phase, was usually not so great as on the normal chewing side; in some individuals the action was virtually reduced to displaced outwards. Individuals with food on both sides of the mouth were seen to displace food backwards over the tongue on both sides, the two columns approaching the midline just above the epiglottis. The column on the side

on which chewing predominated was the larger.

There were some individuals who showed an irregular sequence of movements; chewing was followed by munching or vice versa, or by movements associated with the adjustment of the position of the food in the mouth. In the opening phase, there were some individuals who deviated the mandible towards the side opposite to that on which chewing was going to take place: these persons brought the jaw back to the midline and then swung it over to the chewing side in the preparatory phase (Hildebrand, 1936, 1937). In the preparatory phase of the chewing cycle there were some individuals who did not always make the maximum lateral movement of the mandible and others in whom the crushing or grinding phase was not completed before the mouth began to re-open.

There were also some who made the preparatory lateral movement towards the chewing side as the mandible was lowered. Others raised the mandible and began the medial movement before the food was pressed between the teeth. In all these movements the tongue served to adjust the position of the food and the cheeks to limit its accumulation in the alveolo-buccal sulci: in none of these experiments was the patient given sufficient food to require it to be stored in the checks. When the molar or premolar teeth had been extracted the movements sometimes forced food into the alveolo-buccal sulci, and especially when food was held on both sides of the mouth.

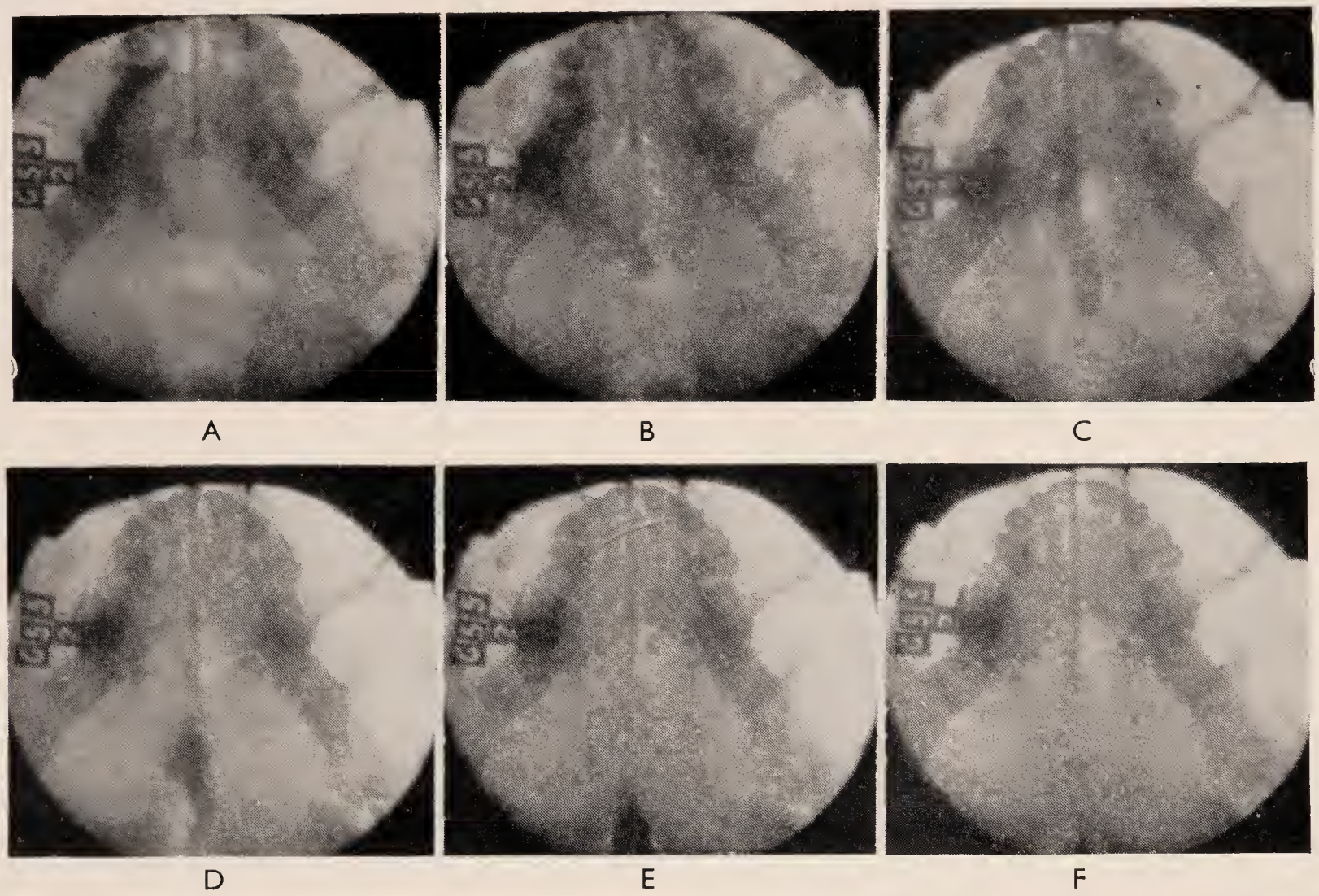



*Fig.* 6.—A series of prints in the dorsoventral projection showing the passage of food backwards from the teeth during chewing (25 frames per second).

A, Mastication has been in progress for about 2 seconds. A column of food has been passed backwards and medially from the side on which chewing has taken place. B, Eighty-five frames later. The column of chewed food is wider and longer; it has reached the midline. C, Twenty-three frames later. Immediately before swallowing. D, Three frames later. E, Five frames later. F, Three frames later. In D–F the bolus is being compressed downwards.

**The Soft Palate.**—When biting, the soft palate was usually apposed to the back of the tongue. During mastication with the lips closed, the soft palate was shortened and thickened and was usually raised a few millimetres away from the surface of the tongue so that the air in the mouth was in communication with the air in the pharynx.

When chewed food was passed backwards between the tongue and the soft palate in a manner analogous to the rabbit, the continuity between the air in the mouth and the air in the pharynx was usually maintained: if larger food particles were displaced backwards they were held up between the soft palate and tongue in the narrow passage. In man, a good nasopharyngeal airway was maintained until swallowing occurred.

**Swallowing.**—Food, when softened or broken up, was swallowed in one of two ways. It was either returned to the front of the mouth and swallowed in the manner previously described (Ardran and Kemp, 1955) or it was displaced backwards by apposition of the tongue to the palate, on the side on which it was chewed. Food which had accumulated between the posterior aspect of the tongue and soft palate was swallowed in the manner similar to that of the rabbit. In no instance was food swallowed on the side opposite to that on which it was chewed (Wright, Strong, and Kingery, 1949).

## DISCUSSION

Dental text-books contain remarkably little information about the normal actions of biting, the taking of food into the mouth with spoon or fork, and mastication (Dickson, 1959; Hemley, 1944; Klatsky and Fisher, 1953; Jenkins, 1954; Fish, 1952; and Salzmann, 1950). For this reason, as one would expect, there is much confusion in the use of terms to describe these motions. In the preceding paragraphs we have attempted to re-define some of the words commonly used, keeping close to the derivation and meaning given in the *Oxford English Dictionary*. "Champing" is a word sometimes used by dentists for chewing, but we suggest that it should refer to noisy impacts of the teeth in munching and chewing.

Text-book accounts are meagre because there is little evidence, even in man, as to how food is taken and manipulated prior to swallowing. Klatsky (1940, 1955) made a cinéradiographic film of three subjects masticating and swallowing, but gave no detailed description of the movements of the food in the mouth, or of the action of the tongue. The impression we obtain from most writers is that man must chew his food, that it is good for him to do this and good for his teeth: we question to what extent these concepts are true.

Perfect dentition is often stated to be that which allows apposition of all teeth when the jaws are fully opposed in the occlusal position: it is conceded that few people are so well-formed as to allow the jaws and teeth to be perfectly alined in symmetrical relation to the mid-sagittal plain. This concept of normality is almost certainly over-emphasized. Dentists rightly insist that teeth should look well and wear well, but they do not always emphasize that they should function well. The explanation may be that there are few objective methods for recording the efficiency of biting and chewing and no agreed standards. Ciné-radiography may be one answer to this problem. By this means we have shown that it is possible to record the movements of artificial dentures when eating various kinds of food of different consistency. The method can be used to compare the functional stability of dentures made by different methods (Ardran, Kemp, and Munz, 1957). Askew (1959) has used radiography to study the food distribution during mastication in 61 subjects wearing full artificial dentures: he did not describe normal behaviour and did not distinguish between mastication, munching, and chewing.

Our studies of the mechanism of eating, drinking, and swallowing in animals indicate that many facts may be learnt which can be applied to the study of man; the differences between the species are not so fundamental as has hitherto been supposed. The rabbit has teeth and jaws which are well suited for the purposes of biting, chewing, and gnawing; when awake it spends much of its time feeding, and has therefore much more experience of chewing than man. He grinds down the most tough vegetable matter very thoroughly, and never swallows unchewed pieces; yet the alinement of the rabbit's teeth and jaws, by the concepts described for man, is far from perfect. The rabbit bites or cuts soft food-stuffs by opposing its principal incisor teeth

edge to edge, and it slides the chisel edge of the lower incisors over the wear surfaecs of the upper incisors when it euts long, tough stems. Man makes similar movements. Most dentists agree that the incisors of the upper and lower jaws overlap, but do not stress the sliding of the lower ineisors upon the upper as a normal phenomenon during biting; the theoretieal coneept of perfect dentition almost precludes this. Cinéradiography should prove a valuable research method for analysis of the borderline problems of overbite.

Perhaps one of the clearest aeeounts of the jaw movements of chewing in man and several speeies of animals has been given by Hildebrand (1936, 1937) who distinguished:—

1. An opening movement which was mainly straight down but which in the bison and certain humans swings over to the side opposite that on which chewing will take place.

2. A preparatory movement in whieh there is elevation and an outward swing of the mandible to the chewing side.

3. A crushing or grinding movement as the jaws are approximated and as the lower teeth move medially to the centric position.

Our findings in the rabbit and in man are in keeping with these conclusions.

The actions of biting, mastieation, swallowing, and speech have all been implicated as faetors eoncerned in the normal development of jaws and teeth, but there is no general agreement as to their relative importance. Many authorities support Rix (1946, 1953), who stressed the behaviour of the tongue in children during swallowing. Dickson (1959) states no case of malocclusion has ever been linked with masticatory function. As to the truth, or otherwise, of these views we cannot comment, but it is obvious that these questions cannot be answered dogmatieally until the normal has been established.

The need for an animal to chew its food to maintain good health and to preserve its teeth may also be questioned. The dog tears or chops its food up, and swallows it in lumps; we have confirmed this einéradiographically. Childry, Alvarez, and Nann (1930) found that dogs digested their food much more completely when they wolfed it down in lumps than when they ate it finely ground in the form of Hamburger steaks. The explanation has been given by Gianturco (1934), who showed in the cat that lumps of meat stayed in the stomaeh for hours, and in whieh case there was praetically no residue of food to be recovered from a fistula established in the terminal ileum; whereas when ground meat was given the stomaeh emptied rapidly and a large undigested residue was recovered from the fistula.

Man is omnivorous, but much of his diet consists of soft cereal food, soft vegetable matter, and relatively tender meat; sueh food may be taken without chewing. No-one ean seriously doubt that teeth are useful for biting and for reducing large lumps to small ones prior to swallowing, and it would doubtless help if man chewed fibrous material, such as celery, and tough meat fibres. Our limited studies of chewing leave us with the impression that man does not chew his food very effieiently even when he is told to do so. How well does he chew when he is not observed? Anyone who has inspected vomit or the contents of stomaehs at neeropsy knows that food is frequently unchewed and the stools often contain relatively large pieees of food material. Thirty years ago physicians plaeed a great deal of emphasis upon the condition of a man's teeth in the aetiology of indigestion, but at the present time interest in this aspect of dyspepsia has waned. Many studies have been made to test whether man has need to divide his food finely by chewing, and the consensus of opinion is that it is of little value (Alvarez, 1939).

**Acknowledgements.**—We are greatly indebted to Professor F. Robert Munz for access to his library and for many helpful and stimulating discussions, and to Miss E. Emrys-Roberts and Mr. M. S. Tuckey for technical assistance.

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## *DISCUSSION*

*The President*: Thank you, Dr. Kemp, very much indeed for explaining your research to us, and Dr. Ardran for showing your wonderful films. They are really most instructive. It is very fascinating research that you are doing. I call on Mr. Rix to open the discussion.

*Mr. R. E. Rix*: We have listened to and seen a pioneering piece of work and we all congratulate both the authors on their technical skill and patience. This work is of considerable interest to our members since, of course, we think there is some correlation between the shape of the dentition and the habitual behaviour of the musculature in and around the mouth.

My pleasure in opening this discussion is tinged with a little dismay since, although I have followed their earlier work, I have not had a preview of the present paper. It was interesting to have the question of the negative pressure within the mouth demonstrated. I think it is the first time it has been demonstrated so clearly. Another fascinating point was the demonstration of the movements of the condyles during lateral movements of the mandible.

As to cessation in breathing in the infant in breast feeding, I do not know whether Mr. Gwynne-Evans is here to-night, but I can remember a film of his—not a cinéradiographical film—of a young child being fed with a bottle, with a cold mirror held up to its nose; and so far as my memory serves me, there appeared to be no interruption at all in breathing. If Mr. Gwynne-Evans is here, perhaps he can tell us whether he had any other interpretation of this finding.

Another point of interest was the position of the tip of the tongue in relation to the lower gum. The lower gum always supported the tip of the tongue as the neck of the teat was first constricted. I think Mr. Leighton, in a fairly recent paper, said that in examining a lot of children he found some who did not have the tip of their tongue supported by the lower gum pad. If this is a true observation one would imagine that the tip of the tongue must be capable of exerting a quite forceful upward stroke.

In an earlier paper—and perhaps this is a good opportunity to raise the point—the suggestion was thrown out that perhaps unsatisfactory properties of a teat might have some deleterious effect upon the action of the tongue, which later might cause some deformation of the dental arches. In looking at dentitions we cannot tell whether a child was breast- or bottle-fed. The suggestion should not, I think, be given too much weight.

I shall leave queries to others, but I do thank the authors again for a wonderful exposition of early feeding. It is a field which they have cornered, and nowhere else do I think can we turn to find such valuable information.

*Mr. Oliver*: I am sure we are all very much impressed by the marvellous pictures of Dr. Kemp. I do not consider myself professionally worthy to discuss them, but there was one little point on which I should like to dwell for just a moment. I believe Dr. Kemp told us that in man the chewing habit is unilateral. I am sorry to hear that, if it is true. We all try to persuade our patients to chew on both sides, and it seems to me that if it is the fact that man chews unilaterally we shall not be very successful in persuading patients to adopt proper habits and to help to keep their mouths dentally fit in this way. I am wondering how many cases Dr. Kemp investigated and what was their dental condition. Were they unilateral chewers because they were dentally fit or simply by habit?

*Mr. E. Gwynne-Evans*: It has given me pleasure to hear Dr. Ardran and Dr. Kemp talk again. A few years ago, the late Professor James Whillis and I spent more than one happy day with them at Oxford, where we much admired their work and rather coveted their apparatus for ciné-analysis, which is able to project continuous loops of ciné-film, either as "moving pictures" at varying speeds or, as "stills", frame by frame.

It is some years now since I described the suckling cycle. Like most primitive rhythms, the suckling cycle, once initiated, tends to continue though the source of stimulus is removed. Thus I was fortunate in being able to film in slow motion the suckling cycle in the oral cavity of an infant with a bilateral hare-lip and cleft extending through the upper alveolus, but not the palate. On removal of the teat from the mouth, the pumping action of the tongue and the muscles of the floor of the mouth could be clearly seen. At no time did we see the posterior pharyngeal wall; at the end of each cycle the dorsum of the tongue appeared to be heaped up against a tensed soft palate. There was no accumulation of milk in the oral cavity; it was presumed that a squirting action of

the tongue and soft palate forced the milk past the faucial pillars into the lateral food passages of the pharynx.

At that time we had no access to cinéradiography as a means of investigation. Dr. Russell Reynolds, however, produced for us one cinéradiographic film of an infant suckling which clearly showed: (1) A rhythmical tensing of the soft palate against the posterior part of the tongue dorsum (lateral view), and (2) Two almost continuous streams of milk flowing through the lateral pharyngeal passages (anteroposterior view).

I am defending my views now, as I am one of those who believe that, in suckling, the milk passes from the mouth through the pharynx with very little, if any, interruption of breathing.

The lessons of comparative anatomy must also be taken into consideration. Sir Victor Negus has shown with unquestionable evidence that variations in the structure of the larynx and pharynx in the animal world are related to different requirements of function. He has shown that in herbivoræ (who feed continuously for long periods of time), the epiglottis is just behind the mouth, contacting the soft palate, and in some species is actually intra-narial. This arrangement allows continuous breathing (essential to the preservation of a high level of olfactory sense) whilst semi-liquid food passes round the laryngeal aperture protected by upstanding aryepiglottic folds.

Although the epiglottis of man never contacts the soft palate, the level of the larynx in the neck is much higher in infancy than in the child or adult, and it is still my view that the feeding behaviour of infancy reflects our herbivorous ancestry. I believe that the sphincteric systems of the pharynx and larynx are utilized in swallowing a collection of fluid in the mouth, but, otherwise, are not fully employed in early infantile feeding.

I congratulate Dr. Ardran and Dr. Kemp on the excellence of their X-ray evidence to support their views.

*Mr. Ritchie*: I should like to thank Dr. Ardran and Dr. Kemp for their work, and to take up the differentiation between munching and chewing. I do not really believe there is any such thing as vertical hinge movement of the mandible. This is, I think, something which appears to be the case radiographically but which in fact does not ever occur. To prove this point one can look at attrition marks of teeth. To prove how much the mandible moves in patients with differing dentitions one can use an overlay to go over all the teeth, raising the bite a little. On the upper or lower overlay are put stainless steel pins and the patient bites with these overlays in place for a few days. The stainless steel pins in one overlay will scratch the opposing overlay and show you the mandibular range for that patient. Although radiographically it will appear there is a hinge movement of the mandible in some cases, I believe this movement also contains some lateral movement at the same time.

*Mr. Tulley*: I should like to add my thanks to Dr. Ardran and Dr. Kemp for the very interesting evening we have had. I would like to ask one question on technique. I am rather concerned about dosages in this particular work, particularly as I referred at the December meeting to the problem of serial studying of children. In the short runs of film shown to-night, approximately what dosage did they get, and how frequently can this be done with safety on children?

Secondly, I should like to take issue with those people who have been talking about chewing. We do not know very much about chewing; that is a fact. Mr. Oliver expressed some surprise to hear that people chew only on one side. It is a fact that most people have a habit of chewing mainly on one side or the other.

*Mr. Hovell*: May I expose my ignorance by asking one or two fairly simple questions? About breathing during suckling, I wonder whether Drs. Ardran and Kemp could tell us what is the mechanism and the action of the airway in view of the somewhat different anatomical relations of the infant and adult. Secondly, during the course of my life I have had fairly considerable experience of infant suckling, and it strikes me that a normal woman feeding her child takes more than four minutes to do so. And is it good for a child to take a full feed of milk in four minutes?

It was mentioned that early in mastication the teeth did not bite through. Is there always a gap, or is cinéradiography not sufficiently accurate to demonstrate this? Then, when the food accumulates at the back of the tongue as was shown, what stops it from running down? Does it hitch up against the epiglottis?

*Miss Clinch*: Would Dr. Kemp tell me just what are the functions in suckling of the lips and of the gum pads and the tongue? Has he any observations to make on how much gum pads are used in chewing? It has been observed that people with a very deep incisor overbite are much more inclined to munch than to chew because the lateral movement of the mandible is very much more difficult in mastication. I think there are definitely individuals who munch more than is usual. Thank you very much for a most interesting paper.

*Capt. Levy*: May I ask Dr. Kemp whether he thinks there has been any recent change in masticating efficiency in the human in view of the change in the texture of the food?

*Dr. Kemp*: I should like to answer some of the points that have been raised. Dr. Ardran and I are great admirers of Gwynne-Evans and his colleagues, and we very much regret that we are not in a position to discuss many of the orthodontic problems they have studied.

I do not think there is any doubt whatsoever that the larynx is shut every time a bolus is swallowed. We have observed this when children are suckling at the mother's breast, and when taking food from a bottle. The goat and lamb, who take milk and barium very quickly, shut the larynx with almost every suckling action, but a bottle-fed baby does not shut its larynx until it has accumulated sufficient food in the back of the mouth to stimulate a swallowing reflex. With a soft pliable teat there may be one teatful per swallow, but if the teat is not soft there may have to be several suckling movements for one swallow. When a baby is being breast-fed the motions are performed quickly: observations made at the level of the baby's nose are not likely to reveal when the larynx closes. I emphasize that the shutting of the larynx is not necessarily an indication of a flow of air into or out of the lungs.

We have read with great interest Mr. Leighton's work, and do not doubt that there may be infants who do not put the tongue over the lower gum: all that we can say is that in our material we have not seen children of this type. I think Mr. Leighton made the point in his paper that his children were a little older than ours. We do not know when normal children cease to protrude the tongue over the gum.

As to our remarks about the physical properties of the teat in the relationship to orthodontic problems, we believe that some babies have to do an enormous amount

of work to overcome the difficulties created by the hard-rubber teat, and we think that the use of such teats may be a factor worthy of further study in orthodontic problems: we do not stress this point any further.

With regard to the time of feeding. Pædiatricians have established that babies obtain about 90 per cent of their feed from the mother's breast in the first three minutes, and we know that the healthy baby, and lamb, may be fed very quickly without ill effects. If you feed a baby with a difficult teat it will swallow more air than when it obtains a good flow.

On the question of unilateral chewing, we took 50 unselected individuals and the only criterion was that they said they could chew: we excluded people who had gross dental malformations. I plead that our report is not of any value statistically: all we can say is that, broadly speaking, the human appears to follow the same pattern of feeding as the rabbit.

With regard to munching or chewing, we feel satisfied that the broad distinction between these is true, but is a matter which should be studied further. We would not discount the value of making observations from attrition marks. We feel that the formation of an attrition mark should be correlated with cinéradiological investigation.

We have described the mechanism of the closure of the airway in great detail in other publications: there are marked changes in the level of the nasopharyngeal closure with growth. When we swallow, the epiglottis is turned down, but the cover valve theory is not correct. It is possible to swallow without an epiglottis, but an epiglottis is useful. The larynx has a sphincteric mechanism which can close it from the vocal cords to the superior laryngeal orifice.

Why does food not spill down into the pharynx? It does. In the rabbit there is a perfect seal between the soft palate and tongue, which may serve to hold up food, but in humans food will spill down around the airway without exciting a swallowing reflex. This is especially true in infants and in older people. In old people food may spill down the airway if a feeding cup is used.

In another demonstration we emphasized that in most of the people we studied when chewing, the seal between the soft palate was not made effectively. It seemed that food was sticking to the tongue. The epiglottis forms a little shelf at the bottom of a gap between tongue and soft palate, and if there is a big enough bolus it may help to arrest it, but we have not seen the epiglottis being used for storage purposes, although we do describe a state of arrest at the level of the epiglottis in normal swallowing. In the rabbit the epiglottis does not seem to play a part in storing whilst chewing.

*Dr. Ardran*: On the question of dose, we have in infants been careful to keep the dose down. Usually we have taken not more than two films—with a dose of about half a roentgen to the skin. We have not needed to carry out any study repeatedly. Two or three full-size pictures give a higher dose than does a small ciné film lasting four to eight seconds. The dose is quite small.

*The President*: Thank you, Dr. Kemp and Dr. Ardran, for coming here this evening and telling us all about your fascinating research, and also for facing this barrage of questions. It has all been most enjoyable. I hope you will make some of your work a serial study so that it will not be long before we have the pleasure of your company here again.

I should like also to thank Mr. Rix and all those who took part in the discussion. Let us show our appreciation in the usual way.

*The vote of thanks was carried with acclamation and the meeting then concluded.*

# ASPECTS OF THE TRANSITION FROM THE DECIDUOUS TO THE PERMANENT DENTITION*

## PART II

By **EILEEN M. E. BONNAR**, L.D.S., D.D.O.
*Department of Orthodontics, Royal Victoria Hospital, Belfast*

In Part I of my paper "Aspeets of the Transition from Deeiduous to Permanent Ineisors" (*Trans. Brit. Soc. Orthodont.*, 1956, 41) I dealt exelusively with ehanges in the oeelusal relationships of the bueeal segments. In this seeond part of the paper I wish to deal with other developmental ineidents noted in the same ehildren and have grouped them under the following headings:—

1. Angular relationships of the upper and lower permanent ineisors at various stages of development showing:—

*a*. Independent "positioning" of the upper and lower ineisors.

*b*. Change of direetion of eruption of the upper permanent ineisors.

2. Diserepaney between upper and lower eentres in the deeiduous and permanent dentitions.

*Fig.* 1.—Cases showing independent positioning of the upper and lower permanent ineisors. A, Typieal example in permanent dentition, potentially normal ocelusion. Upper and lower ineisors lingually inelined, bite very elose. B, The lingual inelinations of the eentral incisors of A during eruption. (Models separated by rubber band beeause of very elose bite.) C, Different ease of normal oeelusion. Earlier stage before the upper and lower permanent ineisors make eontact (normal oeelusion). D, Post-normal occlusion showing very early lingual tilting of both upper and lower permanent ineisors.

3. Attrition and forward movement of the lower areh.

4. Rotations of the upper and lower ineisors in the deeiduous and permanent dentitions and their relationship to laek of spaee.

5. One non-standard mode of upper permanent lateral ineisor eruption.

6. Relationship between spaeing (or laek of it) of the deeiduous ineisors, inereases of the intereanine width, and alinement of the permanent ineisors.

* Part I of this paper appeared in the 1956 *Transactions* and in the *Dental Practitioner*, 1956, 7, 42.

Given at the meeting held on Mareh 14, 1960.

## 1. ANGULAR RELATIONSHIPS OF THE UPPER AND LOWER PERMANENT INCISORS AT VARIOUS STAGES OF DEVELOPMENT

*a.* **Independent "Positioning" of the Upper and Lower Permanent Incisors.**—In the introduction to Part I it was stated that malocclusions are most commonly seen when the full

*Fig.* 2.—Change in direction of eruption. A, The upper permanent central incisors very vertical on eruption, lower incisors lingually inclined and imbricated. Bite close. B, Same case as in (A) approximately two years later. Considerable labial inclination of both upper and lower incisors, with some reduction of the overbite.

upper/lower relationship between the permanent incisors has been established. The closeness of that relationship created the impression that the malocclusions were due to the interaction of the two groups. For example a frequent type of malocclusion is one in which there is a lingual inclination of both upper and lower permanent incisors, with increased incisal overbite. What are the factors responsible for this end-result? Is it because the lower incisors, which, as a rule erupt first, have a lingual tilt from a very early stage and therefore do not give the necessary support to the upper incisors? The latter, which may have been erupting normally, then "collapse" lingually also, until contact with the lower incisors is established. Or, in these cases, could it have been the upper incisors which erupted first with a lingual inclination and thus prevented the lower incisors from coming forward into a normal position?

From the evidence here presented there is what I have termed "independent positioning of the upper and lower permanent incisors". It is seen from the models (*Fig.* 1) that the lingual inclination is present from the first appearance of the teeth, so that the relationship is established by continuing eruption on the initial path. It is not a matter of the upper incisors collapsing on the lowers, or of the lower incisors being held back by the lingual inclination of the uppers.

In most of these cases after the upper and lower permanent incisors do make contact there is no change in the relative inclination of either, but both may become even more lingually inclined or slightly more labially. This incisal relationship occurs where the anteroposterior relationship of the lower to upper arch is either normal or post-normal.

It is known, however, that should the normal relationship established between the upper and lower permanent arches be upset by the loss of a tooth, or teeth, from either arch, there may be repercussions in the unbroken arch. Often the upper permanent incisors incline lingually following the loss of a lower permanent molar (one incisor, generally a lateral, being excluded from the arch labially).

This is a secondary condition and quite different from the primary condition under consideration.

Also, it must not be presumed that there never is any interaction between erupting and erupted permanent incisors. Cases are well known where individual incisors, either upper or lower, which have erupted in a labial or lingual position, are the means of forcing their opponents into abnormal positions.

*b.* **Change in Direction of Eruption of Permanent Upper Incisors.**—Friel (1927) has shown that one of the ways by which the larger permanent upper incisors are accommodated in the arch is by their being more labially

inclined. These models (*Figs.* 2–4) show that in a considerable number of eases (more than 50 per eent) this labial inelination of the upper permanent ineisors is aequired after the crown has been erupting in a vertieal direetion, sometimes even in a lingual direetion. It is not necessarily a continuous growth in a labial direetion from the first appearanee of the erown. This ehange in the direetion of eruption is most elearly seen in those eases wherc, had it not oeeurred, the upper permanent ineisors would have oeeluded lingually to the lower incisors. In most of the eases where it oceurs, it is of sueh a degree that it ean easily bc seen bcfore taking measurements. There were no habits or abnormal muscle patterns that eould be deteeted in these eases whieh would aecount for this labial tilting.

As the tables show, the labial inclination of the upper ineisors, when fully erupted, may be:—

i. The same as during the proeess of eruption —unchanged from the first appearanec of the erown.

ii. Aequired during eruption from original lingual inelinations.

iii. Aequired during eruption from original vertieal positions.

iv. Acquired during eruption from original labial inelinations.

The only other refcrencc to this aspeet of incisal eruption is by Baume (1950). He says that thc upper ineisors are guided into position by the lower incisors, thc latter having erupted first.

The models both in this group and in the previous one show that it is not a matter of

*Table I.*—Dealing with the Labial Inclinations of the Upper Permanent Central Incisors, and showing how it Changes or not, as the Teeth Erupt

Belfast Models
(Total, 50)

*A*

1. Number where $\underline{1|1}$ erupt lingually inclined — 14 →
   - 3 Do not change
   - 10 Tilt labially →
     - 5 Where $\underline{1|1}$ only reach vertical positions
     - 5 Where $\underline{1|1}$ become labially inclined
   - 1 (No final models)

2. Number where $\underline{1|1}$ erupt vertically — 21 (18 B/L, 3 U/L) →
   - 3 Do not change
   - 17 Tilt labially →
     - 14 Very definite, $\underline{1|1}$ labially inclined
     - 3 Slight movement only
   - 1 Tilts lingually

3. Number where $\underline{1|1}$ erupt with labial inclination — 17 (13 B/L, 4 U/L) →
   - 5 No change
   - 10 Tilt labially →
     - 9 Very definite
     - 1 Only slightly
   - 1 ? change
   - 1 (Only one)

4. Total number where the labial inclination increases from 1, 2, or 3 — 36 (34 B/L, 2 U/L) →
   - 10 From Group 1
   - 17 From Group 2
   - 9 From Group 3

5. Number where $\underline{1|1}$ became more lingually inclined — 1 Slight lingual movement from 1 in Group 2 after $\underline{1|1}$ had tilted labially

Therefore labial inclination of $\underline{1|1}$ increases in 34 cases out of 50, i.e., 68 per cent.
In 39 cases where $\underline{1|1}$ are labially inclined in the end:—
- 17 Erupt with a labial inclination (increased in 10)
- 17 Have changed from original vertical position
- 5 Have changed from original lingual inclination

*B*

No change at all in:— 11 Cases
- 3 From Group 1
- 3 From Group 2
- 5 From Group 3

} 12 per cent

i.e., in 12 per cent the original lingual or vertical relationship of $\underline{1|1}$ to occlusal plane remains throughout.

B/L = Bilateral; U/L = Unilateral.

the upper incisors coming into contact with the lower incisors and then being forced one way or the other along a sliding plane. They may be vertically, lingually, or labially inclined on eruption, and continue in these directions, or become more labially or more lingually inclined *before* they come into contact with the lower incisors (*Figs.* 1–3).

Only if one has been fortunate enough to have frequent models of children's dentitions during the period of eruption of the incisors former and 59·5 per cent of the latter. (*See Tables I* and *II.*) The occlusion in most of these cases is normal, but in a few it is post-normal on one or both sides and in one it is pre-normal.

Only the behaviour of permanent upper central incisors has been dealt with in detail and measured for the purposes of this paper, but it was observed that the labial inclination of the permanent upper lateral incisors and of the permanent lower incisors does become increased also (*Figs.* 2, 3).

*Table II.*—Dealing with the Labial Inclinations of the Upper Permanent Central Incisors, and showing how it Changes or not, as the Teeth Erupt

London Models
(Total, 47)

1. Number where $\underline{1|1}$ erupt with lingual inclination
   - 12
     - 2 No change
     - 10 Tilt labially →
       - 5 Definite movement →
         - 2 Where $\underline{1|1}$ become labially inclined
         - 3 Where $\underline{1|1}$ still only vertical
       - 5 Only slight movement

2. Number where $\underline{1|1}$ erupt vertically
   - 18
     - 4 Do not change
     - 12 Tilt labially →
       - 10 Where $\underline{1|1}$ become definitely labially inclined
       - 2 Only very little labial movement, $\underline{1|1}$ still approximately vertical
     - 2 Only one model

3. Number where $\underline{1|1}$ erupt labially inclined
   - 22
     - 10 No change
     - 6 Move labially
     - 4 Less labially
     - 2 Only one model

4. Total number where $\underline{1|1}$ become more labially inclined from 1, 2, or 3
   - 28
     - 25 Considerable
     - 3 Very slight inclination
     - →
       - 10 From Group 1
       - 12 From Group 2
       - 6 From Group 3

5. Number where $\underline{1|1}$ become more lingually inclined
   - 4 From Group 3 (all very slight degree)

Therefore labial inclination of $\underline{1|1}$ increases in 28 out of 47 cases, i.e., 59·5 per cent.
In 34 cases where $\underline{1|1}$ are labially inclined in the end:—

- 22 Erupt with a labial inclination (increased in 6)
- 10 Have changed from original vertical positions
- 2 Have changed from original lingual inclination

No change at all in:—
- 16
  - 10 From Group 3
  - 4 From Group 2
  - 2 From Group 1
  - } 12·76 per cent

i.e., in 12·76 per cent the original lingual or vertical relationship of $\underline{1|1}$ to occlusal plane remains throughout.

can this change of direction be detected. It can be shown in degrees by measuring the angle of the labial surface of the upper permanent incisors and the occlusal plane at the various stages of eruption. This angle was measured on 50 Belfast models and on 47 of Miss Clinch's London models. It was found that the labial inclination of the permanent upper central incisors increased in 68 per cent of the

## 2. DISCREPANCY BETWEEN UPPER AND LOWER CENTRES IN DECIDUOUS AND PERMANENT DENTITIONS

In a surprising number of the deciduous dentitions it was noted that the upper and lower centres do not correspond with one another. Using the median palatine raphe as a guide, it is seen that in most cases the fault is in the lower arch. In the small number of cases

where the upper eentre is definitely off, it was generally found that there was a sueking habit, and so they were not ineluded. In a few, also, the upper eentre is to one side and the lower eentre to the opposite side. There is also a small number where it is very diffieult to be sure whieh eentre is at fault using simple

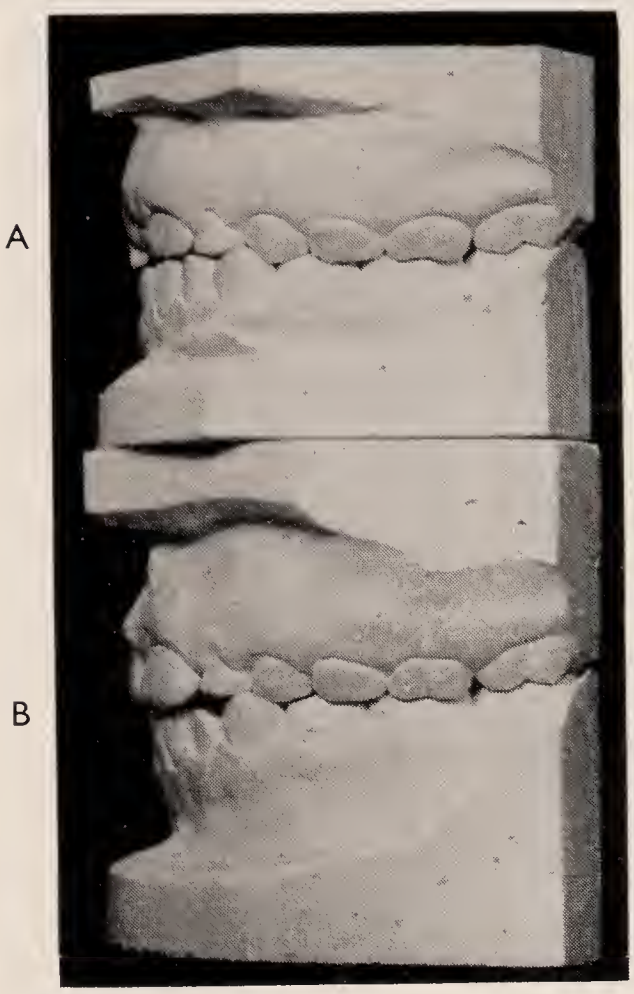


*Fig.* 3.—Earlier stage. A, The upper permanent central incisor partially erupted and slightly lingual to thc lower central incisor. B, Same case a few months later, before the upper and lower incisors make contact.

means, so in order to simplify the results I have, in all eases, eharted the relationship of the lower centre to the upper centre and not the relationship of either to the median palatine raphe.

This diserepancy in the eentres is of very early origin, seen in the earliest models and in one ehild at 12 months. It seems extremely probable that it was present at the time of eruption of the ineisors. Once established it is earried right through the ehange-over period and appears to be approximately the same degree in the permanent dentition in the majority of cases. There was no reduetion of either arch in any of these partieular eases.

Asymmetry of the eentre may, of eourse, be influeneed by any premature extraction of teeth in either areh, espeeially in the lower (*Fig.* 8).

If the extracted teeth are permanent ones, and espeeially if these are lost at an early age, there is a definite and permanent effeet on the relationship of the upper and lower eentres. For example, if the lower eentre had been off

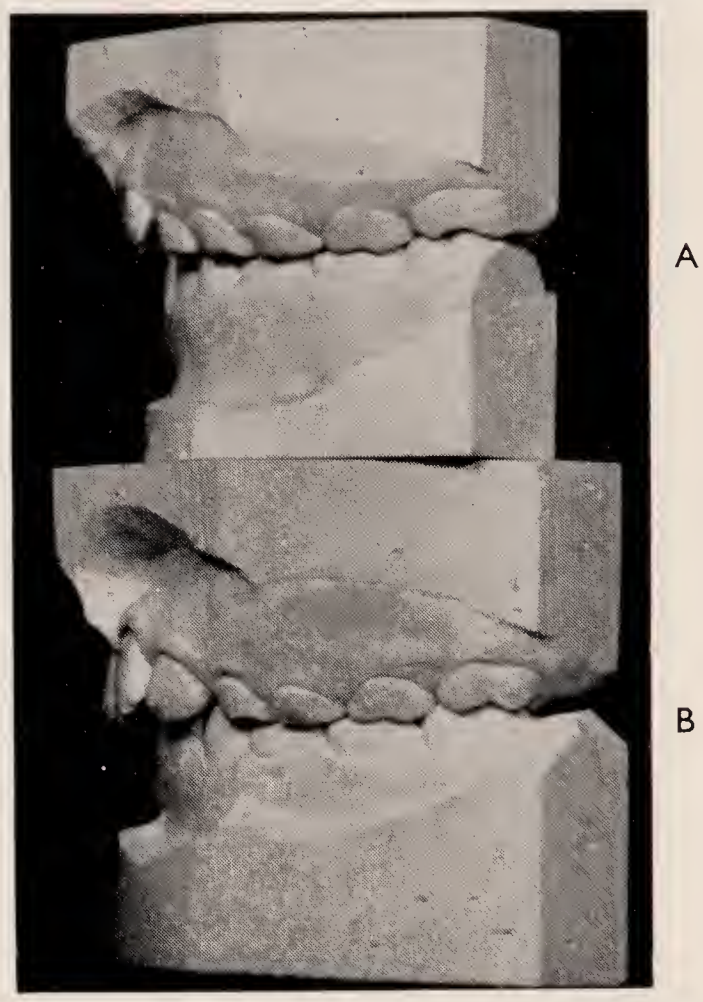


*Fig.* 4.—A, The upper permanent central incisors erupting very vertically, but considerably labial to the lower incisors. B, Samc case when the permanent upper laterals have crupted.

to the left originally, it will move to the right of the upper eentre on the loss of a permanent tooth in the lower right bueeal segment. The nearer to the centre the extraetion takes place, the greater the deviation of the eentre.

With early loss of the deeiduous teeth, however, the pieture is somewhat different, depending on whieh teeth are extraeted, the age, and whether or not there is erowding of the teeth. If a eanine or molar, partieularly a first molar, is lost in a erowded areh at an early age, it is almost eertain to result in a deviation of the eentre to that side.

Where there is premature loss of one or more lower deeiduous ineisors, the position of the lower eentre may ehange, but this ehange is often only a temporary one. The original relationship of the eentres may be established

on the full eruption of the lower permanent incisors. The position of the lower centre can also vary a bit as the lower permanent incisors are erupting (*Fig.* 9), particularly where there is some initial lack of space, though it is also seen to occur where there is no crowding. It does, however, revert to the original central position on full eruption of the lower permanent incisors, if it was central in the deciduous dentition.

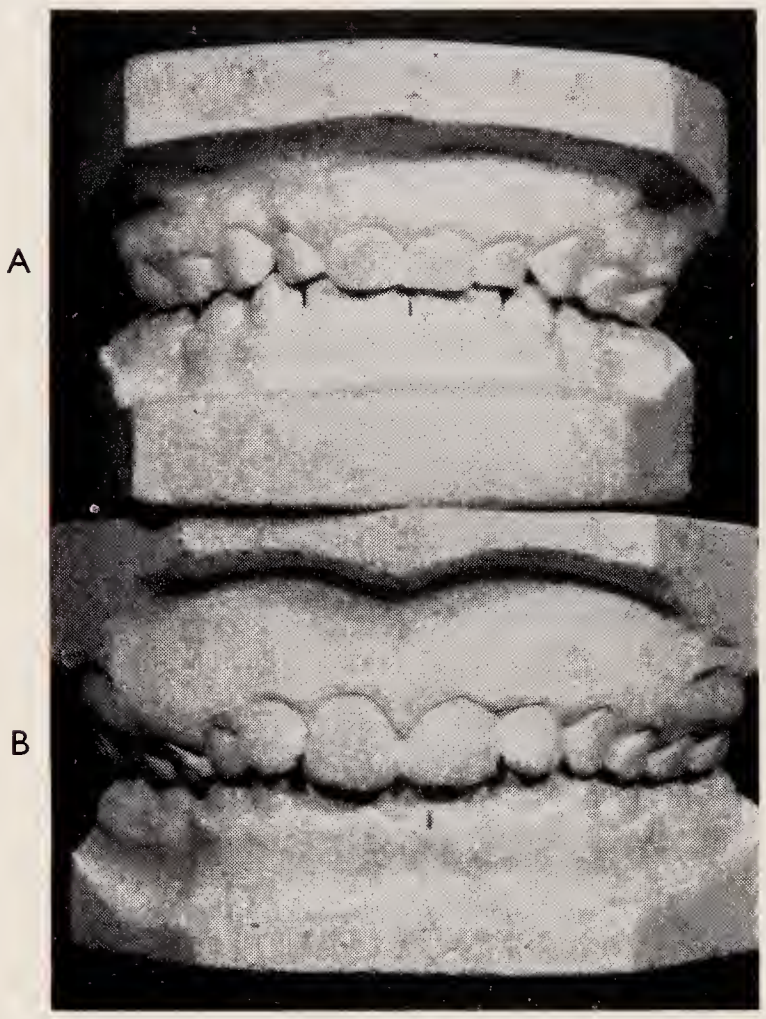


*Fig.* 5.—A, Lower centre to the left of upper centre at $3\frac{1}{2}$ years. B, Same case at $8\frac{1}{2}$ years.

*Fig.* 6.—Left side of *Fig.* 5. A, at $3\frac{1}{2}$ years. B, At $8\frac{1}{2}$ years. *Note* the post-normal relationship of lower arch, before and after the eruption of the first permanent molars.

*Fig.* 7.—Occlusion of *Fig.* 5 on right side. A, At $3\frac{1}{2}$ years. B, At $8\frac{1}{2}$ years. *Note* the forward movement of lower arch and normal occlusion of the first permanent molars.

It should be noted that where the upper arch is narrow and a bite of convenience established, the relationship of the upper/lower centres can change according to the teeth erupted. These cases are not included in this study.

In no instance, in the Belfast cases, where the discrepancy is present in the deciduous dentition is it absent in the permanent dentition though it may be of lesser degree. However, this did happen in one of the London models (1 per cent), so that contrary to what I had concluded, it is possible for the discrepancy to be corrected (though not probable). In this one case, the lower centre was off to the left at $3\frac{1}{2}$ years. There was a distal relationship of the lower left buccal segment to the upper, while on the right side the lower buccal segment was in a forward relationship to the upper. Then, in the deciduous dentition,

a dramatic change took place, the lower left buccal segment moved forward until, at the time of eruption of the first permanent molars, the distal surface of the lower second deciduous molar was anterior to that of the upper corresponding tooth, and the upper and lower centres came to correspond. No forward movement on the lower right side took place, but there was a slight reduction of the overbite. There were no spaces at any time between the deciduous teeth.

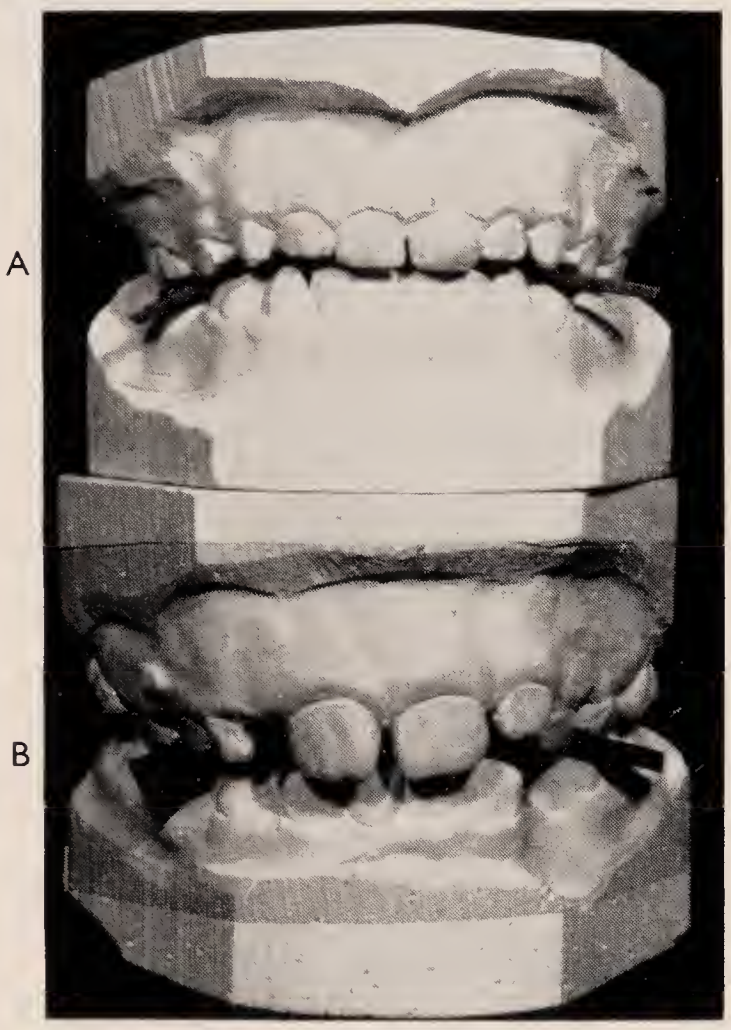


*Fig.* 8.—A, Lower centre to the right at $3\frac{1}{2}$ years. There was early loss of the lower left first molar. B, The lower centre well off to the left when the upper and lower permanent incisors erupt. It remained there.

There is a marked association between discrepancy of the centres and a distal relationship of the lower buccal segment on the side to which the lower centre is deflected (*see Tables*). These, in conjunction with the sequence of events in the above case, would indicate that a cause of the discrepancy in the centres is a very early lack of forward growth of one lower buccal segment (*Table III*).

It is interesting to note that in one (Belfast) case (*Figs.* 10, 11), where the lower buccal segment made up for this initial lack of forward growth at a late stage (after $\overline{2|2}$ had erupted) so that the arch relationship became normal, the discrepancy in the centres was still present, though to a lesser degree. It would appear

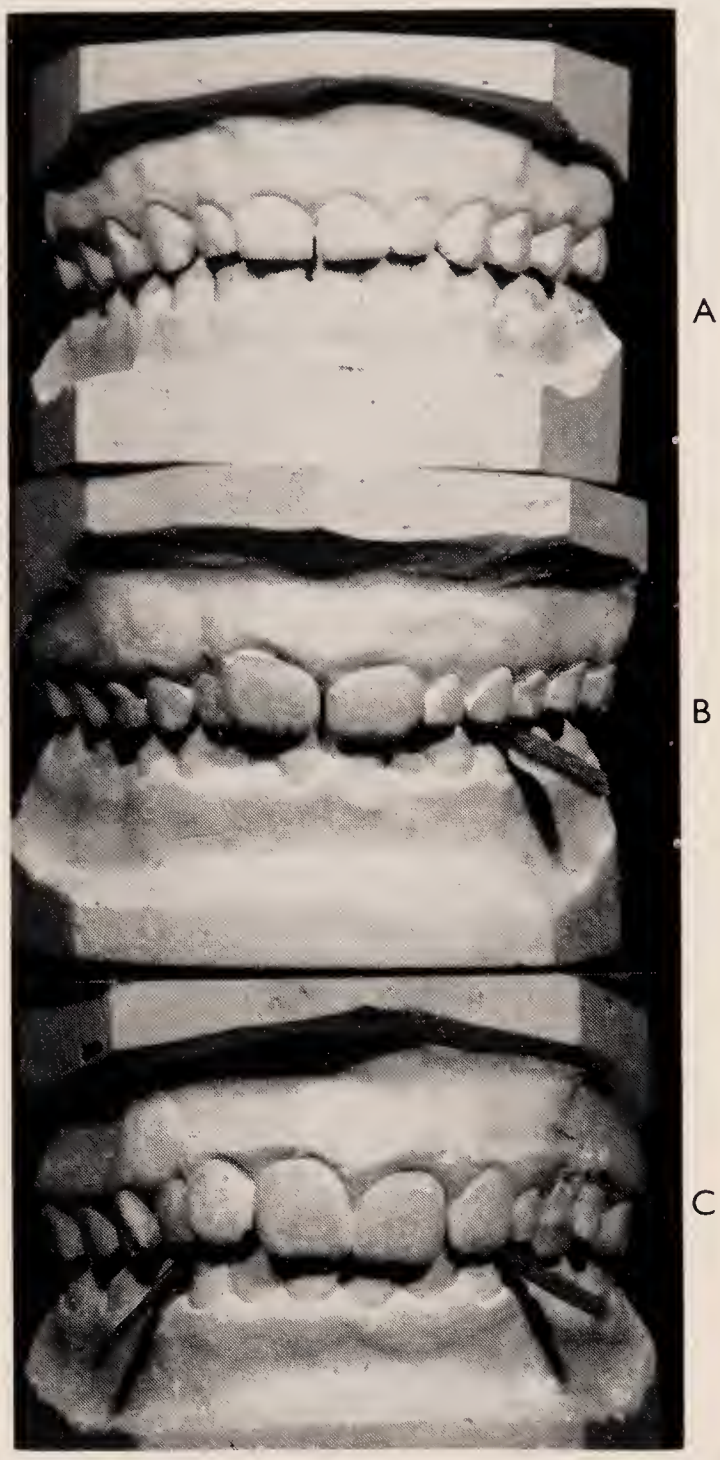


*Fig.* 9.—A, The lower centre to the right of upper centre in the deciduous dentition. B, Lower centre to the left now when the permanent lower centrals have erupted, but before the lower left lateral incisor has fully erupted. C, The lower centre over to the right again when the lower left lateral has erupted.

that only when forward movement of the lower buccal segment takes place at an early stage—before the lower permanent incisors are fully erupted—is it likely that the original discrepancy in the centres will be corrected.

Reference was made to this subject by Delabarre in 1819. He examined 338 children under 7 years of age and found there was a deviation of the incisal median planes in 44·6 per cent.

He concluded, "Deviation of the incisal medial lines is more than an occasional indication,

and because of the serious maldevelopment that may follow, and the consequent technical difficulty of reduction, it should be given a place of more importance in diagnosis".

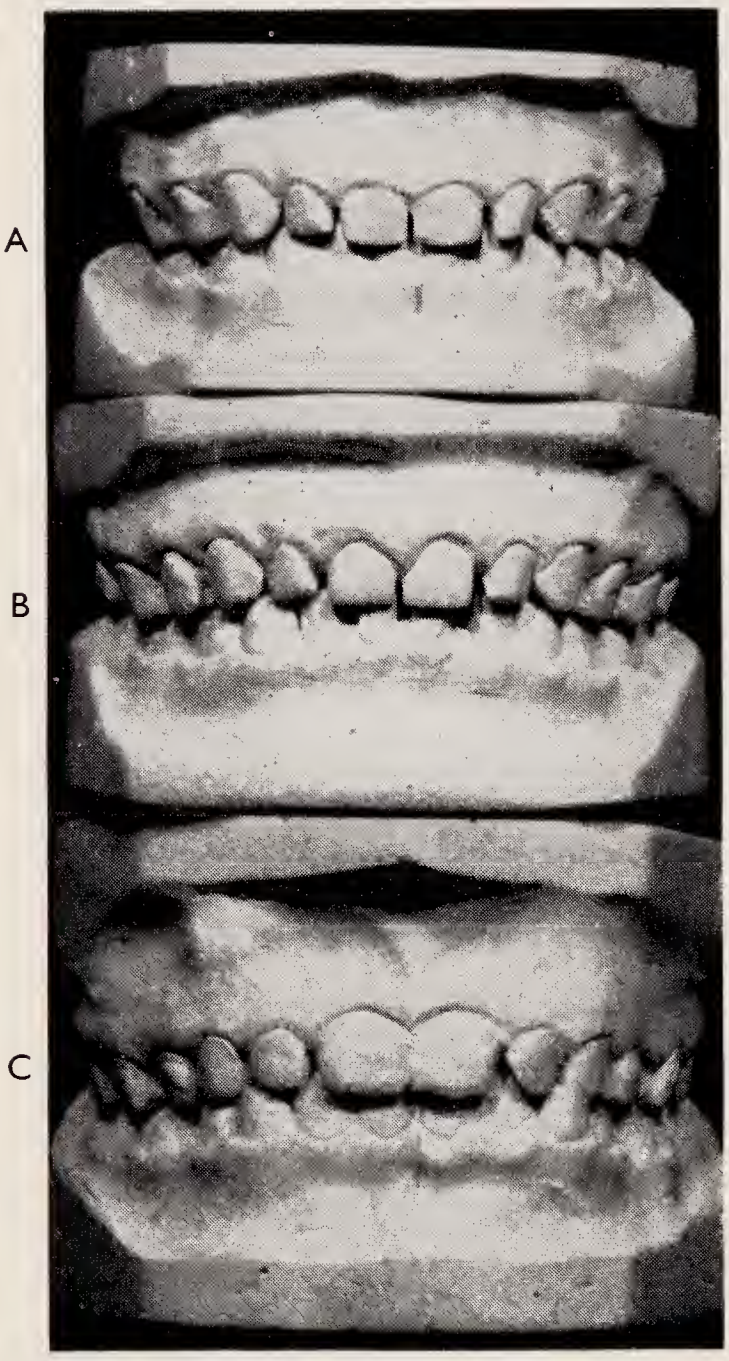


*Fig.* 10.—A, Case before first permanent molar has erupted showing lower centre deflected to the left, frontal, and left occlusal views. B, After it has erupted. C, The lower centre is still to the left even though the lower left buccal segment had moved forward into normal occlusion. *Note* both show the lower centre to the left of upper centre. Note the increased spacing (particularly in the lower) of the deciduous incisors in (B).

## 3. ATTRITION AND FORWARD MOVEMENT OF THE LOWER ARCH

The relationship between attrition of the deciduous teeth and forward movement of the lower arch has never been established. Looking at the normal deciduous dentition in occlusion one concludes naturally that unless there is attrition of the canines and incisors at any rate, no more forward relationship of lower arch to upper can be established.

Observing that in many deciduous dentitions incisors and canines do become worn down, one is tempted to infer that any more forward relationship of lower arch is "due to" attrition.

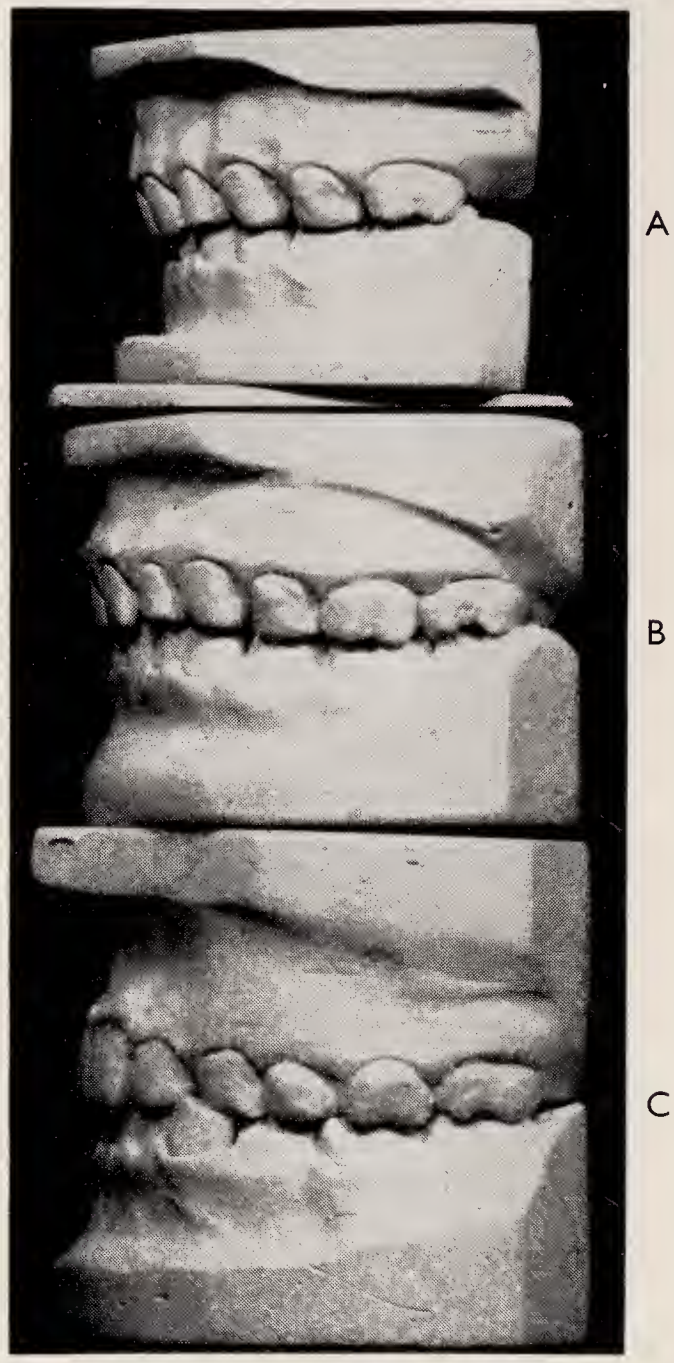


*Fig.* 11.—A, Same case as *Fig.* 10. B, *Note* the distal relationship of the lower arch on the left side. C, After eruption of permanent incisor. The lower arch has moved so far forward that the first permanent molars now occlude normally.

My observations on the children recorded seem to disprove both conclusions and to leave the nature of the relationship much more obscure (Bonnar, 1956).

In Part I of this paper (1956) it was shown that forward movement of the lower arch is not confined to one period, but can take place at different stages, and also that the forward relationship of the lower arch can be present from the first appearance of the teeth.

There is no simple correlation between attrition and forward movement of the lower arch. It is usual for attrition of the deciduous

*Fig.* 12.—Attrition. A, Left occlusal view. The lower arch well forward at $3\frac{1}{2}$ years, yet no attrition of the deciduous canines. B, Eight months later. The lower arch has moved further forward, yet no attrition of the deciduous canines is visible.

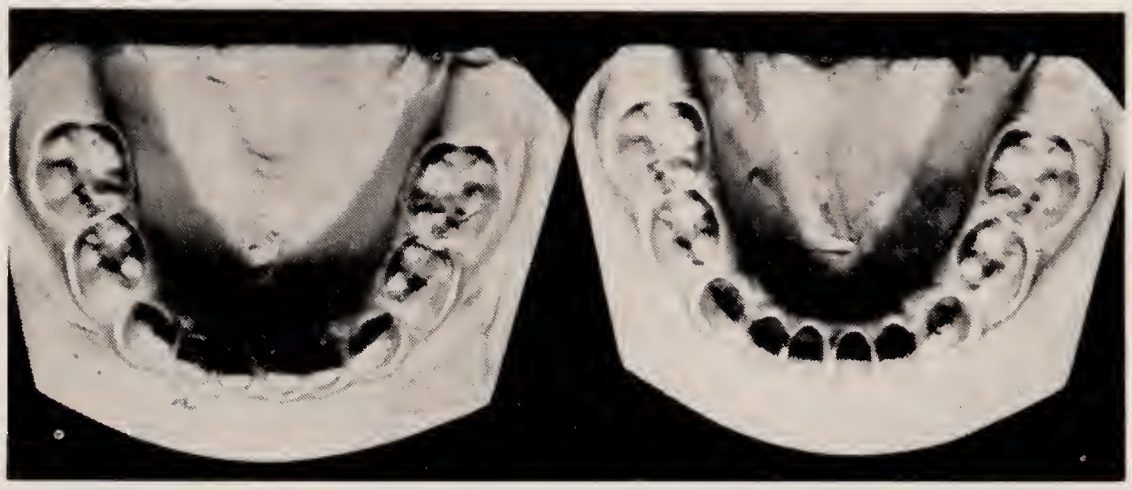

*Fig.* 13.—Attrition. Occlusal views of the lower arch of case in *Fig.* 12 showing the sharp cusps of the deciduous canines and molars.

teeth to take place, but there is great variation both in the amount and in the rate at which it takes place. Some of the deciduous teeth are found to be well worn down shortly after the deciduous dentition is completed, in others there is very little wear by the time they are due to be shed.

As the tables show, it does not follow that in the former the lower arch has moved forward, while in the latter cases no forward movement has taken place. Quite often in those instances where the lower arch is, at $3\frac{1}{2}$ years, in the forward relation to the upper arch, which was not previously thought to be established until around 6 years, there is very little, or no, attrition of the teeth (*Figs.* 12, 13).

On the other hand, in many cases there has been so much attrition that the molar occlusal surfaces are worn quite flat, yet the lower arch

*Table III.*—Discrepancy between the Upper and Lower Centres in the Deciduous and Permanent Dentitions, and its Association with the Anteroposterior Relationship of the Upper and Lower Arches

Belfast Models

(Total, 52—44 only counted. No teeth extracted in either arch.)

Discrepancy in U/L centres in deciduous dentition and permanent dentition found in:—

25 { 15 Lower centre ——→ R. / 10 Lower centre ——→ L. } 56·8 per cent

In 23—Lower arch was in a more distal relationship to the upper on one side to which lower centre is deflected.

U/L centres corresponded in deciduous dentition and permanent dentition in 19 cases.

In 1 of these there is a difference in relationship U/L arch on one side.

London Models

(Total, 43)

Discrepancy in U/L centres in deciduous dentition found in:—

18 { 9 Lower centre ——→ R. / 9 Lower centre ——→ L. } 40·86 per cent

Corrected in 1 case in permanent dentition, i.e., { Lower centre ——→ lower in deciduous dentition / U/L centres corresponded in permanent dentition }

In 14 of these 18 cases the lower arch was in a more distal relationship/upper on side to which lower centre is deflected.

In 2—Very slight discrepancy and no detectable difference in the arch relationships.

In 1—No spacing $\overline{d\text{–}c|}$ on the side off-centre, spacing $\overline{|c\text{–}d}$, but end arch relationship same on both sides.

In 1—Lower in Class III relationship and no detectable difference in either side.

U/L centres corresponded in deciduous dentition and permanent dentition in:—

25 cases and of these in

9 there is a more distal relationship L/U on one side.

has not changed its relationship to the upper arch (*Figs.* 14, 15).

In individual cases, also, there is not an even rate of attrition. In one period of six months or a year there may be no apparent wear of the deciduous teeth, but in the succeeding similar period, a great deal. These periods, that could be termed "active" and "non-active" as regards attrition, do not coincide with the periods of movement or stationary relationship of the lower arch, as movement takes place depends on other factors, chief of which seems to be some inherent force which can even overcome adverse environmental conditions such as lack of attrition (*Table IV*).

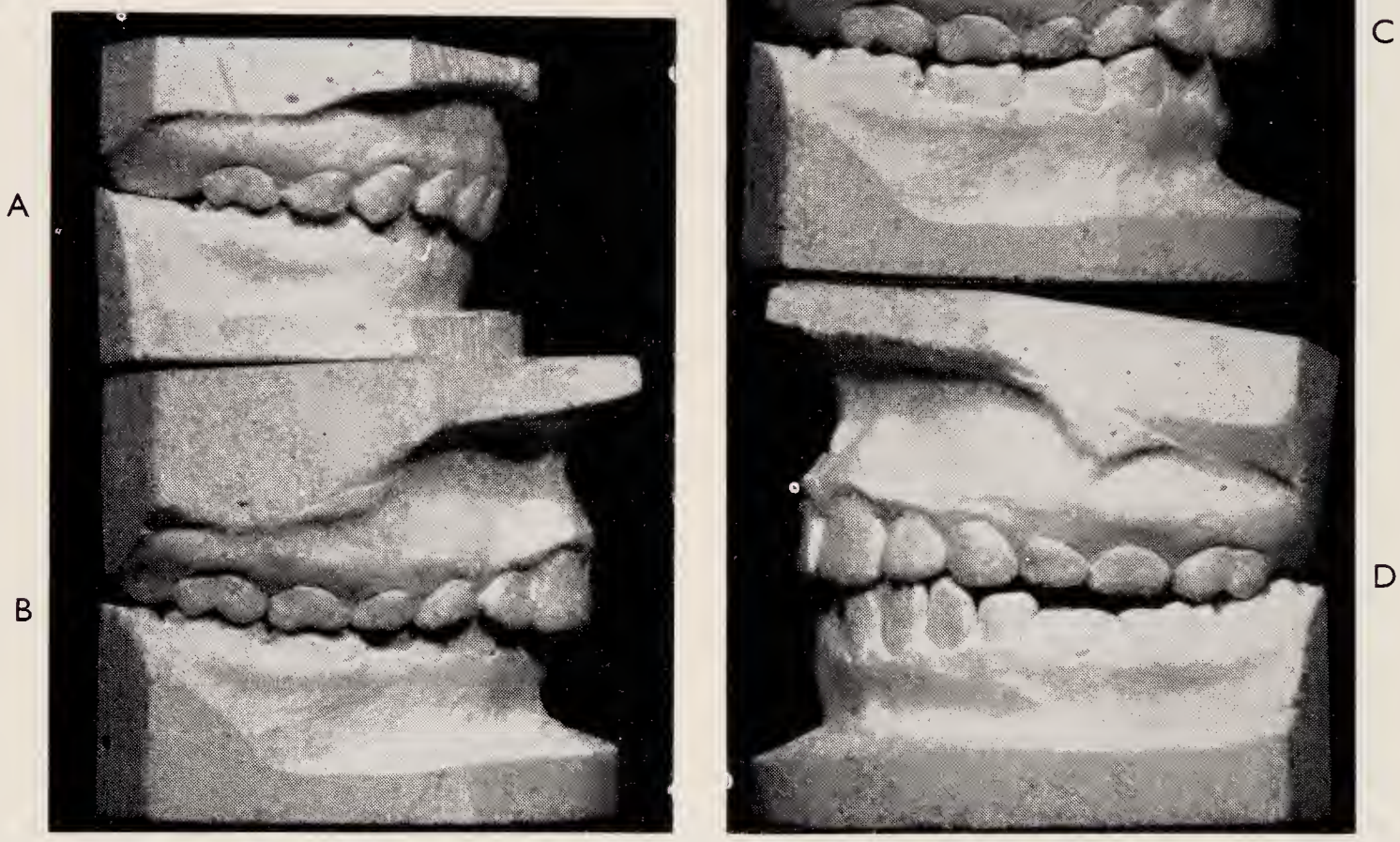


*Fig.* 14.—Attrition. A, Shows occlusion of the right upper and lower buccal segments at $5\frac{1}{2}$ years. B, Same case at $8\frac{1}{2}$ years. Considerable attrition of the deciduous canines yet negligible forward movement of lower arch. C, Same case. The relationship of the buccal segments on the right side during the movement of the lower jaw to the right. *Note* how the attrition has occurred on the medial surface of the tip of the upper canine and on the distal surface of that of the lower incisor. D, Same case. Left side, showing the relationship of the upper and lower buccal segments during the movement of the lower jaw to the left. (As the lower centre was off to the left, the lower left buccal segment was distal to the upper left buccal segment on closure.) *Note* how the attrition of the upper deciduous canine on this side is on the distal mesial surface, while that of the lower deciduous canine has taken place on the medial mesial surface. (Compare with C.)

would be expected if attrition was a vital factor in forward movement of the lower arch. If the facets on the upper and lower teeth, caused by attrition, are examined, it will be seen that in many cases the lateral movements of the lower jaw are more closely connected with attrition than forward movement (*Figs.* 14 C, D, 15 B). Therefore, although it seemed logical to presume that if no attrition of the deciduous teeth takes place, there could be no forward movement of the lower arch, these models show that in reality such conclusions cannot be drawn. Whether or not this forward (Baume, 1950, found that function and wear of teeth had little influence on the establishment of a normal molar occlusion.)

## 4. ROTATIONS OF THE UPPER AND LOWER INCISORS IN THE DECIDUOUS AND PERMANENT DENTITIONS AND THEIR RELATIONS TO LACK OF SPACE

Rotations of the deciduous incisors are quite common, though generally they are of slight degree only. In these models, rotations of the lower deciduous incisors occur more frequently than rotations of the upper deciduous incisors.

There is a closer association between lack of space and rotations of the deciduous incisors in the lower arch than in the upper arch. In the latter there was spacing in 50 per cent of the cases of rotated incisors, crowding in 33·3 per cent, and close incisal contacts in 16·6 per cent; while in the lower arch there was spacing in 30 per cent, crowding in 40 per cent, and close incisal contacts in 30 per cent.

There is no correlation between rotation of the deciduous incisors and rotation of the permanent incisors. As the permanent incisors go through a stage of crowding before eruption starts, many adapt themselves to lack of space at that stage by rotation. After eruption the crowding may still exist, in which case the rotations remain much as on the first appearance of the tooth, but even though there is adequate space the incisors remain rotated in many instances.

Here the upper and lower permanent incisors differ somewhat. As can be seen from the following tables, rotations of the lower permanent incisors are mostly found where there is lack of space for even alinement of all the teeth (*Figs.* 17, 18) (i.e., in 78 per cent, compared with 36 per cent in upper), while in the upper the reverse is true. In the majority of the cases of rotated upper permanent incisors (64 per cent) there is ample, if not more than enough, space available (*Fig.* 16).

In the lower there was self-correction of the rotation in 56 per cent of cases (50 per cent complete, 50 per cent partial), while in the upper the equivalent percentage was only 18·2 per cent. There was no self-correction at all of the rotations in 72·7 per cent of the upper cases, compared with 37·5 per cent of the lower cases.

If one took permanent incisors as an overall class one would be led to conclude that the chances of self-correction occurring are very much less in originally "spaced" conditions,

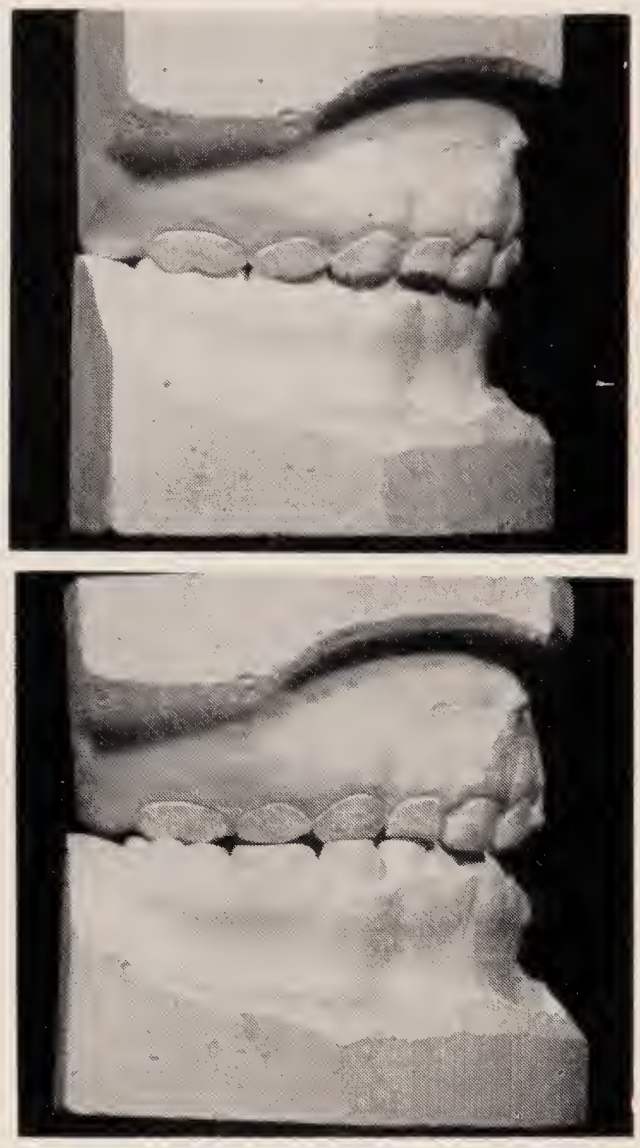


*Fig.* 15.—Attrition. A, Considerable attrition of the deciduous canines associated with a distal relationship of the lower arch. B, Same case showing the movement of the lower jaw to the right. *Note* how the attrition facets on the deciduous canines correspond with the contact surfaces on lateral movement.

*Table IV.*—The Association between Attrition of the Deciduous Teeth and the Anteroposterior Relationship of the Upper and Lower Arches

(Total, 47)

Forward relation of lower/upper arch from very early stage:—

In 18 cases
- No attrition in 5
- Very slight degree attrition in 6
- Considerable attrition in 7

Where lower arch had moved forward in relation to upper arch:—

In 23
- 14 B/L
- 9 U/L

→
- No attrition in 7
- Very slight degree attrition in 8
- Considerable attrition in 8

} 16 Attrition plus forward movement

Where lower arch did not move forward at all in relation to upper arch:—

In 13
- No attrition in 0
- Slight attrition in 4
- Considerable attrition in 9

} 13 Attrition and no forward movement

than in originally crowded conditions. Detailed examination of the cases, however, reveals that this is true only as regards upper permanent incisors. In the lower arch, though crowding is almost four times more commonly found associated with rotations than spacing, the proportion of self-corrected rotations in each condition is approximately the same, i.e., full

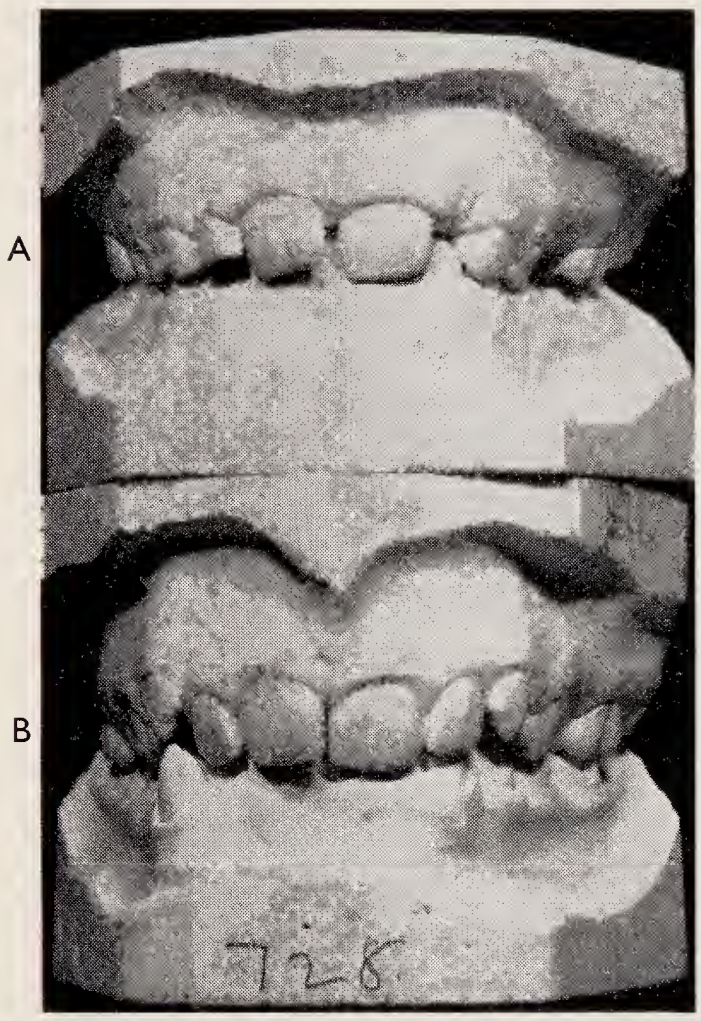


*Fig.* 16.—A, Rotation of the upper right permanent incisor during eruption. B, Four years later. Plenty of space from beginning, but no self-correction.

*Fig.* 17.—A, Rotation of the upper right permanent central incisors and lower right lateral—insufficient space. B, Eighteen months later, the upper and lower intercanine width has increased and the rotation of the upper right central and lower right lateral incisors are partially corrected. Now the upper laterals are erupting, short of space and isolated. C, Eighteen months later. Shows almost complete correction of the upper and lower rotations. Increase of intercanine widths and also increased labial inclination of both upper and lower permanent incisors.

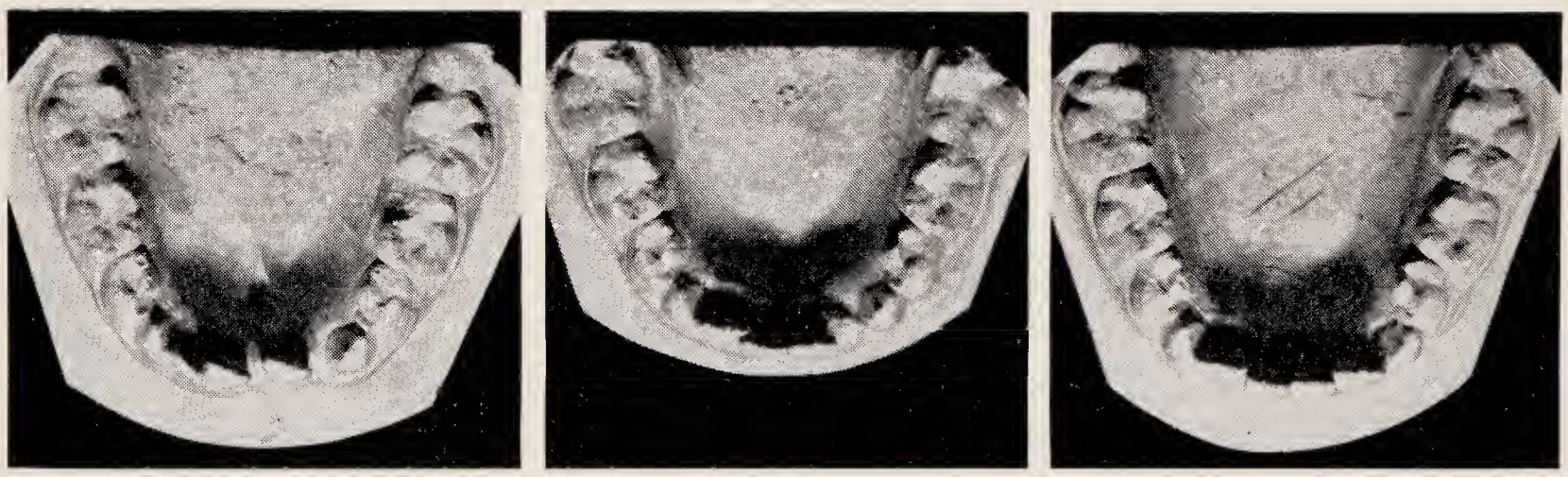


*Fig.* 18.—A, Occlusal views of lower arch of another case, showing rotation of the left permanent central incisor on eruption and spacing. B, Permanent laterals erupting, rotation of central now corrected, but left lateral now rotated, very short of space. C, Six months later. Increase of the intercanine width and correction of the rotations almost complete.

correction in 28 per cent. In the upper where there was spacing, there was full correction in only 7 per cent, whereas in crowded conditions the percentage was 25 per cent (*Figs.* 16–18 and *Table V*).

It has been found that the greatest increase in the intercanine width takes place just prior to and during the eruption of the permanent incisors, upper and lower (*see* Sect. 1*b*). Therefore in the majority of cases, as the permanent incisors are erupting, the space available is increasing and a great many of them, which are rotated on first appearing, particularly lowers, become corrected as they erupt. This was noted by Baume (1950), who stated that the strongest growth impulse in the mandible was during the eruption of the permanent second incisors, and first incisors which were rotated slightly became straightened when the laterals erupted.

Besides this increase of the intercanine width there is also, as described in Section 1, (*b*) of this paper, a tendency in many cases for the upper and lower incisors to become more labially inclined as they erupt. This labial tilting, or inclining, has an important bearing on rotations also (*Fig.* 17). In a few cases, both upper and lower, where there was no increase of the intercanine width, yet the rotations were corrected, it was found that the incisors had inclined labially sufficiently to give the space necessary for even alinement of all the teeth.

It would therefore appear that rotations of the permanent incisors can be separated, to begin with, into two groups.

i. Those due to lack of space, not only at the time of eruption, but subsequently.

ii. Those of very early pre-eruption origin, independent of spacing.

These latter do not become corrected, though ample space is available during the whole eruption period (*Fig.* 16).

*Table V.*—The Relation between Rotations of the Upper and Lower Permanent Incisors and Sufficient or Insufficient Spaces

Belfast Models

(Total, 47)

| |
|---|
| Rotation of upper permanent incisors in 22 instances (22 models) |
| Rotation of lower permanent incisors in 32 instances (25 models) |
| Ample space for upper permanent incisors in 64 per cent |
| Ample space for lower permanent incisors in 21·9 per cent |
| (Therefore lack of space for upper permanent incisors in 36 per cent) |
| (Therefore lack of space for lower permanent incisors in 78·1 per cent) |
| Complete correction of rotated upper permanent incisors in 13·63 per cent |
| Complete correction of rotated lower permanent incisors in 28·35 per cent |
| Partial correction of rotated upper permanent incisors in 4·6 per cent |
| Partial correction of rotated lower permanent incisors in 27·9 per cent |
| No chance of correction at all of upper permanent incisors in 72·7 per cent |
| No chance of correction at all of lower permanent incisors in 37·5 per cent |

Most of the rotations of the lower permanent incisors belong to Group 1, while the majority of rotations of the upper permanent incisors are in Group 2.

The proportions of self-corrections of rotations is very much greater in the case of lower permanent incisors than of upper permanent incisors, though there is no association between spacing and lack of self-correction in the lower, as is found in the case of upper permanent incisors.

## 5. ONE NON-STANDARD PATH OF ERUPTION OF THE UPPER PERMANENT LATERAL INCISOR

Quite often patients are referred to the orthodontist when the permanent upper lateral incisors are erupting or have just erupted, because, instead of these teeth being placed in an even alinement between the permanent central incisors and the deciduous canines, they are tilted somewhat distally, their disto-lingual surfaces overlapping the mediolabial surface of the deciduous canines.

In many of these cases there is a slight shortage of space and the distal tilt of the upper laterals appears to be due to a lag in growth in width of the maxilla at the apical level. Broadbent (1941) has recorded this in frontal

radiographs. It can also occur where there is spacing between the incisor crowns.

The temptation is to advise expansion of the upper arch or extraction of the deciduous canines where there is some crowding. In an earlier survey of 390 primary schoolchildren in Belfast this relationship of the permanent upper laterals was noted in 150. In the present study, and also in Miss Clinch's series, it occurred in 20 per cent.

No treatment was carried out and when the permanent canines had erupted the central incisors, lateral incisors, and canines were all in normal alinement. The original relationship of the lateral incisor was a temporary one, and should be regarded as being within the range of the normal at that age (*Fig.* 19).

## 6. RELATIONSHIP BETWEEN SPACING (OR LACK OF IT) OF THE DECIDUOUS INCISORS, ALINEMENT OF THE PERMANENT INCISORS, AND INCREASES OF THE INTERCANINE WIDTH

This is one aspect of the development of the occlusion which has received the attention of practically every investigator who has collected, or had access to, a series of models.

There is fairly general agreement that the greatest increases in the breadth of the dental arches takes place in the intercanine distances, that these increases are greater in the maxilla than in the mandible, and that the greatest mean increase in both arches takes place around the time of eruption of the permanent incisors (Colyer, 1920; Lewis and Lehman, 1929; Korkhaus, 1932; Chapman, 1935; Cohen, 1940; Baume, 1950; Clinch, 1951; Barrow and White, 1952; Burson, 1952).

Their conclusions, however, differ with regard to what precedes and follows this increase in the intercanine measurement during the eruption of the permanent incisors. Lewis (1932), Chapman (1935), Baume (1950), Sillman (1948), Barrow and White (1952) found that there was no (or negligible) increase in this measurement between the ages of 2 and 6 years, while Clinch (1951) noted a small increase in both arches before the eruption of the permanent incisors, and Woods (1950) a gradual increase in the upper intercanine measurements, except for a decrease between the ages of 7 and 12 years.

Moorrees (1959) states that in the maxillary arch the increase in breadth takes place during

*Fig.* 19.—A, Upper permanent lateral incisors erupting, tilted distally, spaced from the central incisors. B, Same case when the permanent canines have erupted. Upper laterals now in even alinement.

three phases, each followed by a period during which little change occurs, i.e., (*a*) 3–4 years, (*b*) 5–6 years, (*c*) just before emergence of the permanent canines. After the third phase, the width decreases slightly but definitely until 18 years of age. In the mandible the mean distance between the canines increases continuously and markedly after 5 years of age to a maximum at 10 years of age in males, and 9 years of age in females. Following this growth phase, around the mean age of emergence of the permanent mandibular canines, there is a slight decrease in the average intercanine distance. Little change occurs after the age of 12.

Lewis observed that after the spurt of growth during the eruption of the permanent incisors, there was no increase in the intercanine measurements from 9–10½ years of age. This was then followed by another growth spurt, reaching its maximum at the age of 13. Clinch (1951) found that it continued

afterwards, but at a reduced rate. Barrow and White (1952) found it decreased after the age of 14. Woods (1950) found the mandibular intercanine distance remained more or less constant from 3–5 years of age, but decreased from 6–9 years of age. The great individual variation in these measurements was stressed by Lewis and Lehman (1929), Cohen (1940), Burson (1952), and Moorrees (1959).

With regard to the relationship between spacing of the deciduous incisors and alinement of the permanent incisors, there is less agreement.

Delabarre (1819), Colyer (1920), Baume (1950), Clinch (1951), and Barrow and White (1952) observed that if there were no spaces between the deciduous incisors, it was likely there would be irregularities of the permanent incisors. (Clinch classed such deciduous dentitions as malocclusions.) Neumann (1955) noted that the transition from deciduous to permanent incisors took place in a more regular manner in children with spacing of the deciduous incisors than in those without spacing. The presence of spacing was *mostly* followed by satisfactory alinement of the permanent incisors. He was careful to point out that exceptions to these generalizations were noted. Lewis and Lehman (1929), on the other hand, stated that spacing of the deciduous incisors had little relation to the alinement of the permanent incisors.

Korkhaus (1932) found that spaces between the deciduous incisors did not appear in all children with normal maxillary development —the permanent incisors were *comparatively* often well alined when these spaces were missing. He believed that the presence of spacing indicated a marked difference between the mediodistal crown breadths of the deciduous/permanent incisors.

In this series of models, measurements were taken of the intercanine width, upper and lower, on each model (from mid-cervicolingual aspect), and also the distance between the first deciduous molars, upper and lower, from the mid-cervicolingual points. It is seen that though there may be a slight increase of the intercanine width, both upper and lower (0·5–1 mm.), before the shedding of the deciduous incisors, in the majority of the cases the greatest increase (1·5–3·5 mm.) takes place just prior to and during the eruption of the permanent incisors. This confirms the conclusions of others, as stated earlier.

In 11 cases (23·4 per cent), however, measurements showed a decrease at some stage in the intercanine widths. In 2 of these cases the decrease occurred in the deciduous dentition, near the time of replacement of the incisors. In 1 there was a decrease of 1 mm. in the lower intercanine width, and in the other a decrease of 0·5 mm. in the upper intercanine width. In this latter case there was narrowness of the upper arch and a cross-bite, which could account for the noted decrease. In both cases there was an increase in the measurements during the (time of) eruption of the permanent incisors. In the other 9 cases the decrease took place after the permanent lateral incisors had erupted, and following an increase of 1–2·5 mm. during the eruption of these teeth. The decreases ranged from 0·5–1·5 mm. In 6 of the cases it occurred in the upper arch, 2 in the lower arch, and in 1 both upper and lower. These measurements were found on the last models of the series, i.e., on full eruption of the permanent incisors. Woods (1950) found the intercanine width in the maxilla decreased from 7–12 years and that of the mandible decreased from 6–9 years. As he implies that these decreases were general his results are very different from those noted in this series, or found by the other investigators quoted at the beginning.

Barrow and White (1952) noted that the intercanine distances decreased steadily after 14 years of age, in amounts varying from 0·5–1·5 mm.

With regard to spacing between the deciduous incisors, the deciduous models were divided into 5 groups:—

1. Those with good spacing (1 mm. or over) between all the incisors: (*a*) Upper and lower (U/L); (*b*) Upper only (U); (*c*) Lower only (L).

2. Those with slight spacing between all the incisors: (*a*) U/L; (*b*) U only; (*c*) L only.

3. Those with spacing between some, but not all, incisors: (*a*) U/L; (*b*) U only; (*c*) L only.

4. No spacing between any of the incisors, but even alinement: (*a*) U/L; (*b*) U only; (*c*) L only.

5. Crowding of the incisors: (*a*) U/L; (*b*) U only; (*c*) L only.

*Table VI.*—Deciduous Dentition with Regard to Spacing between the Incisors, showing Numbers in Each Group

| | (*a*) | (*b*) | (*c*) |
|---|---|---|---|
| 1. | 11 U/L | 3 U | 2 L |
| 2. | 2 U/L | 2 U | 2 L |
| 3. | 11 U/L | 10 U | 3 L |
| 4. | 2 U/L | 3 U | 5 L |
| 5. | 2 U/L | 1 U | 6 L |

*Table VII.*—Showing how Each Group in the Deciduous Dentition Worked out in the Permanent Dentition

| *Deciduous Dentition* | | *Permanent Dentition* |
|---|---|---|
| Group A U/L (*a*) | 11 | 2 Group 1 U/L (spaced)<br>3 Group 2 U/L (even)<br>6 { Group 1 U (U spaced)<br>Group 2 L (L even) |
| Group B U/L (*a*) | 2 | 1 Group 1 U/L (spaced)<br>1 { Group 1 U (spaced)<br>Group 2 L (even) |
| Group C U/L (*a*) | 11 | 1 Group 1 U/L (spaced)<br>1 Group 2 U/L (even)<br>3 { Group 1 U (U spaced)<br>Group 2 L (L even)<br>2 { Group 1 U (U spaced)<br>Group 3 L (L crowded)<br>2 { Group 2 U (U even)<br>Group 3 L (L crowded)<br>1 { Group 3 U (U crowded)<br>Group 2 L (L even)<br>1 Group 3 U/L (crowded) |
| Group D U/L | 2 | 2 Group 3 (crowded) |
| Group E U/L | 2 | 2 Group 3 (crowded) |

The models of the permanent teeth were divided into 3 groups:—

1. Those with spacing between the incisors (some or all): (*a*) U/L; (*b*) U only; (*c*) L only.

2. Incisors evenly alined, but no spacing: (*a*) U/L; (*b*) U only; (*c*) L only.

3. Incisors crowded: (*a*) U/L; (*b*) U only; (*c*) L only.

Each case was charted out in this way, so that it was easy to follow them through from the deciduous to the permanent dentitions.

In the deciduous dentition the numbers in each group are as given in *Table VI*.

To simplify the results I shall deal here with those in subdivision (*a*) of each group only (*Table VII*), though each case can be followed through.

If we examine those cases where there is no crowding of either upper or lower permanent incisors (i.e., either even or spaced) and trace from which deciduous group they came, the result is seen in *Table VIII*.

Also, if those cases where there is crowding of both upper and lower permanent incisors are traced back to the deciduous dentition, we have the above results (*Table IX*).

*Table VIII.*—Tracing Back Three Cases in the Permanent Dentition where there was Crowding of the Upper or Lower Incisors to the Deciduous Dentition

| *Permanent Dentition* | *Deciduous Dentition* | |
|---|---|---|
| No crowding of upper or lower incisors in 21 | 11 from A U/L (*a*)<br>2 from B U/L (*a*)<br>5 from C U/L (*a*)<br>1 from { B U<br>C L<br>1 from { B L<br>C U<br>1 from { A L<br>D U | = 4·76 per cent (5 per cent approx.) |

*Table IX.*—Tracing Back Three Cases in the Permanent Dentition where the Upper and Lower Incisors were Crowded to the Deciduous Dentition

| *Permanent Dentition* | *Deciduous Dentition* |
|---|---|
| Crowding of upper and lower incisors in 11 | 1 C U/L = 0·09 per cent<br>3 { C U<br>E L<br>2 D U/L<br>2 { D U<br>E L<br>2 E U/L<br>1 { E U<br>D L |

From *Table VII* it is seen that in all the cases where there was spacing between *all* the deciduous incisors, upper and lower, the permanent upper and lower incisors were either spaced or evenly alined. There was no case of crowding of the permanent incisors.

From the deciduous dentitions in Group C, where there was spacing between some, but not all, of the deciduous incisors, the alinement of the permanent incisors is seen to be more variable. Of the 11 cases, in 5 the permanent incisors were either spaced or evenly alined, whereas in 6 crowding appeared in either lower or upper arch (1 case both upper and lower).

In Group C also it is interesting to note the greater frequency of crowding in the lower permanent incisors. This was found in 5 lower models, compared with 2 upper ones.

In the 4 cases where there was no spacing at all, or crowding, of both upper and lower deciduous incisors, the upper and lower permanent incisors were short of space.

Examination of *Table VIII* shows that of the 21 cases where the permanent incisors were either spaced or evenly alined, in 20 of these there was some spacing of both upper and lower deciduous incisors. In 1 the lower deciduous incisors were well spaced, but there was no spacing of the upper deciduous incisors.

*Table IX* shows that of the 11 cases where there was some crowding of the upper and lower permanent incisors, in 7 of these there was no spacing at all of both upper and lower deciduous incisors; in 3 there was crowding of the lower deciduous incisors only with spacing between some of the upper deciduous incisors, and in 1 there was spacing between some, but not all, of the upper and lower deciduous incisors. These figures would indicate that there is a very definite association between spacing of the deciduous incisors and even alinement of the permanent incisors (with or without spacing) (or conversely, between crowding of the permanent incisors and lack of spacing of the deciduous incisors). It must not be overlooked, however, that in 4·76 per cent (5 per cent approximately) of those cases where the upper and lower permanent incisors were in good alinement, there was no spacing at all of the deciduous upper incisors and in 9·1 per cent of the cases of crowding of both upper and lower permanent incisors, there was spacing between some, though not all, of both deciduous upper and lower incisors, and some spacing of the deciduous upper incisors only in 27·3 per cent.

There may also be an irregularity of the permanent incisors due to lack of space, apparent when these teeth erupt, but which is self-corrected at a later stage. In those cases of "late alinement of the permanent incisors" the extra space may be obtained (*a*) by further increase of the intercanine width or (*b*) by increased labial proclination of the permanent incisors, sometimes both (*a*) and (*b*).

There are cases, too, where the "over-all" intercanine width is sufficient to accommodate all the permanent teeth in even alinement, but there is spacing between some of them and overlapping of others. The teeth are not able, of themselves, to make the most of the space available.

Neumann (1955) stated that "the differences in the increments of arch breadth and length can be evaluated only when dental development has progressed further", and these findings would indicate that the same holds good with regard to the final alinement of the incisors.

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## *DISCUSSION*

*The President* thanked Miss Bonnar for another fascinating paper, and commented on the tremendous amount of hard work she had put into it. It seemed to him that they just could not have enough of this series, which was full of information. He then called upon Miss Clinch to open the discussion.

*Miss L. M. Clinch*: I would like to thank Miss Bonnar for another paper on what is, naturally, to me a subject of great interest. It is most useful to get someone else's point of view about one's own serial models which, no matter how often one has studied them, always seem to provide some details which had not been noted previously; I know them well, but I am well aware that there is much more to be learnt from them. As I read Miss Bonnar's paper three things impressed me: first the infinite variety of paths along which individuals may progress to reach the same goal; secondly, how useless it is to attempt to apply statistical data to individual development which can vary so much; and thirdly, how wise Professor Friel was to give the title of "Ideal" to his description of the development of occlusion. Many paths *may* lead to the same goal, but there is only one which leads there with the minimum of risk of interference *en route*.

I would be very interested if Miss Bonnar could give more details of the arch relationship in the permanent dentition of these series as many of the points she makes depend on whether there is normal, post-normal, or pre-normal relationship of the arches to each other. For instance, under her first heading ,"Angular Relationships of the Upper and Lower Permanent Incisors at Various Stages of Development", it is easy to understand that the labial inclination of the upper incisors could well increase if there was a post-normal relationship of the lower to the upper arch. I do not think it is possible to separate the incisor occlusion during development from the molar–premolar occlusion as they depend so much on each other. The soft tissues, particularly the lips, and habits could also cause the inclination of either upper or lower incisors to vary at different stages in the same individual. However, I am sure some of the cases described by Miss Bonnar in which the labial inclination of the permanent incisors increases as the teeth erupt have normal anteroposterior arch relationship, but I would like to know if she has any idea what the percentage is of post-normal or pre-normal mandibular occlusion.

Under Miss Bonnar's second heading where a discrepancy was found between the upper and lower centre lines right through the series, what percentage had had no extractions in either arch? I quite agree that if a first deciduous molar is extracted early (before the eruption of the permanent molars), especially in an unspaced arch, there will almost certainly be a deviation of the midline towards the side of the extraction. By contrast, if a second molar is extracted under the same conditions, the midline may not alter, but the first permanent molar will often erupt in contact with the D, even in the lower arch. Extractions after the eruption of the first permanent molars are much less likely to cause a *permanent* alteration in the midline. I would like to know at what age Miss Bonnar's final models of each series were taken. If it was before the eruption of the permanent canines and second molars I think she would find that the centre line might correct itself later on as her incidence of deviation in her final models is considerably higher than I found at 14 years of age in my series. Miss Bonnar does mention *one* of my series in which the deviation did correct itself in the permanent dentition, but actually after the eruption of the full permanent dentition (except for the third molars). Only 5 had a shift of the centre line; in 4 of these the lower had deviated, resulting in a unilateral post-normal occlusion of the lower to the upper arch.

Miss Bonnar's third heading deals with the connexion between attrition and forward movement of the lower arch in relationship to the upper. Friel states, "attrition and increase in upper canine breadth in the maxillary arch do not mean that the mandibular arch will move forward, there must be the *urge* to do so, but unless attrition occurs this alteration in arch relationship cannot take place". The cusps of the unworn deciduous molars are extremely sharp and the fossæ extremely deep; unless some attrition takes place I cannot understand how their planes will allow alteration in arch relationship. I would have thought that if the alteration takes place through this "urge" of which Friel speaks, the locking of the cusps and fossæ must be released, and this can only be done if there is some wear of the cusps. Has Miss Bonnar noticed if the cusps in the cases where forward movement has taken place without attrition are flatter than usual?

The fourth heading deals with rotations of the incisors. It seems to me that many of these individual variations in the development of good occlusion are due to the fact that the teeth have erupted a little too soon; this could apply to the labial inclination of the incisors. As far as rotations are concerned it has been shown that the lower deciduous incisors are rotated in their crypts. If these teeth erupt before this rotation has corrected itself one sees the typical rotation, mediolingually, of the lower central incisors. However, if there is sufficient space these often move into good alinement. In the same way, the positions of the lower permanent laterals in their crypts is lingual to the line of the arch and this is the position into which they will often erupt—again, given sufficient space, they will usually move forward into the line of the arch. In other words the alinement may take place *before* or *after* eruption, or even more commonly *during* eruption as this is the period of maximum increase in intercanine breadth.

Miss Bonnar's fifth heading deals with the distal tilting of the permanent lateral incisors, which is often seen as they erupt. I certainly agree that no treatment should be advised in these cases. There are many temporary displacements of individual teeth which occur at this early period which may appear to be abnormal, but they invariably correct themselves—such as the spacing of the central incisors which may leave little or no room for the laterals. As the laterals and then the canines erupt the centrals move medially. I would like Miss Bonnar to tell me if she has any of these cases amongst her series.

The sixth heading deals with spacing in the deciduous dentition and the alinement of the permanent incisors. It is interesting to find that in approximately 5 per cent of cases where the upper and lower permanent teeth are in good alinement there was no spacing of the *upper* deciduous incisors. This bears out Friel's theory that there may be root spacing of the upper deciduous incisors which cannot be seen above the gum margin. I think there is no doubt that this root spacing takes place even if the crowns are already spaced, but in the 5 per cent of

cases which show no imbrication of the upper permanent dentition despite lack of spacing between the deciduous incisors there is probably a greater degree of this alveolar growth. I have measured the angle of the labial surface of the upper deciduous centrals to the occlusal plane on serial models and I have found that this angle increases with age, indicating that growth in the alveolar region is taking place and carrying the roots of the deciduous teeth with it although there is no increase in the spacing between the crowns of the teeth. This is obviously one way in which space is made for the permanent incisors.

Miss Bonnar points out that there are many slight differences in the findings of those who have measured alterations in intercanine breadth; this may be due to differences in the points used for this measurement, for instance Moorrees used the tips of the canines—this could well show increases or decreases due to tilting of the teeth and not to increased arch breadth. It must be remembered, too, that most investigators show the average measurement of their series at different stages; it would probably be possible to find an individual case which differed from all their findings.

The trouble with trying to write a paper on serial models is that as no two are alike, one is tempted to give a demonstration on the development in each individual; and I would like to congratulate Miss Bonnar on showing many of these small, and often temporary, variations.

*The Secretary* (Mr. B. C. Leighton) congratulated Miss Bonnar on a very useful contribution to the knowledge of changes that might be expected to take place spontaneously at that time of life. He thought one of the most important points that Miss Bonnar had established was that the labial lingual inclination of the permanent incisors began to be adjusted before those teeth came into contact.

He thought it had been generally recognized that occlusal contact and guidance determined the medial distal relationship of posterior teeth much more than the labial lingual relationship, and the latter were much more at the mercy of muscular influences than of cuspal guidance.

Several questions came to his mind. Miss Bonnar had made no mention of arch relationship or of skeletal morphology. Presumably, those did have some influence on the final inclination of the incisors.

The other question that immediately came to mind was the question of muscular environment. Were the labial or lingual changes in inclination associated with a particular type of muscular behaviour? It might be interesting to speculate whether the more labial inclination occurring in the majority of cases could be associated with the lingual position that these teeth adopted or were found in before they erupted.

He asked Miss Bonnar how she differentiated the deviations within the lower arch from deviations of the mandible on closure towards one side. He had the impression that the latter was quite a common phenomenon; that cuspal guidance in the molar region might carry the mandible slightly to one side, producing a slight post-normality on that side.

There seemed to be some marked discrepancy between the Belfast and the London models in that respect. Could this be due to a different sort of selection between the two groups of models, and, if not, could any significance be attached to it?

Another question he wanted to ask Miss Bonnar was whether the attrition was assessed by examination of the molars or of the incisors, or both? He thought this was rather important, especially in view of what Miss Clinch had just said on the subject. He felt that molar attrition might have been associated with an uncomfortable occlusion, perhaps slight cusp-to-cusp occlusion, and that, in those cases, attrition seemed to be more common.

He congratulated Miss Bonnar once again on the amount of work put into the paper. He knew how difficult these cases were. He was afraid he could not comment really intelligently on it, because the patients in his group were not quite so old as Miss Bonnar's.

*Miss Bonnar* said she had dealt with occlusion in the previous paper and had not wanted to repeat herself too much on this occasion. On the whole, the majority of the cases were normal, or potentially normal, but the various abnormalities of the teeth did occur in some, as would be expected, and also there were some cases of post-normal and pre-normal occlusions.

When considering the angular relationships of the upper and lower permanent incisors, if there was any habit or any abnormal muscle pattern, these cases were not included, only the ones where the environment was normal, as far as she could judge. That was not to say there might not have been any abnormal musele patterns, but they were not deteetable.

When there was a change of direction of eruption of the upper permanent incisors, both Miss Clinch and Mr. Leighton asked about occlusion. The majority of the eases were normal oeclusions, there were a few cases of post-normal occlusion, but only one case of pre-normal ocelusion. One of the cases shown on the screen had been post-normal, all the others were normal occlusions.

When considering discrepancy of the eentres, if there had been any deciduous or permanent teeth extracted in either arch, this would affeet the position of the centres as she had indicated, and these eases were not included. In this group, all the teeth were present, and yet the upper and lower centres did not correspond.

She thought that probably the age of her final cases was not as old as Miss Clinch's. In most of the final models, all the permanent teeth had erupted (except the third molars), but, in some, the deciduous canines were still present. To begin with, she had aimed at recording until the permanent incisors had all erupted, but many had continued longer. Miss Clinch had mentioned that there was not such a discrepancy of the centres in her own later models as in the earlier ones. She was surprised to hear that.

As seen from the slides and the tables, up to the time of the change-over of the incisors and deciduous molars, the discrepancy of the centres remained in all the Belfast models, and all but one of the London models, and she did not expect to find much change after that.

Attrition and forward movement—she had, in discussing attrition, included attrition both of the molars and of the incisors and canines. She had not found many cases where the cusps of the deciduous molars were very sharp. That might be a difference between the Irish and London patients; she did not know. In some cases where they were quite sharp, it did not seem to be a deterrent to the lower arch moving forward. One could see the attrition of the deciduous canines best and that was why she concentrated on showing them on the slides.

As Professor Friel pointed out, the chief faetor in the lower arch moving forward was the urge to move forward, and if the urge was there, the lower can move forward, even if the sharp cusps are not worn down.

Rotation of the permanent incisors—she did not find that the age at which the incisors erupted made any difference. The chief point about rotations was that spacing was more often associated with rotation of the permanent upper incisors than crowding, and if there was spacing in the upper arch, one was less likely to get self-correction, whole or partial, of the rotations, than if there was crowding. Spacing in the upper arch was not a favourable factor, but this did not apply to rotated permanent lower incisors.

[Miss Bonnar agreed with Miss Clinch that the spacing of the permanent central incisors, often found when these teeth erupted, closed as the permanent laterals erupted, and often disappeared altogether when the permanent canines erupted.

She had not mentioned these cases because she thought this was generally accepted, but thought there would be some of them in her series.]

Regarding the differences in the measurements of the growth changes taking place in the dental arches, she knew that a few of the investigators used different points for the measurements, but taking this into consideration, there was still too big a variation in the results.

Regarding Mr. Leighton's point about muscular environment, she had answered that by saying there were no abnormal muscle patterns in the cases in these different groups. Where any abnormality was present, that case was not included.

Where there was a deviation of the lower centre, she had been careful to check the movements of the mandible, and only those cases where there was normal opening and closing were considered. There were no abnormalities of the temporomandibular joint to be found.

Mr. Leighton's other point about attrition had also been answered. Attrition of the molars was considered, besides that of the incisors. The amount of attrition taking place in either of these areas was not always of the same degree, though in normal cases, where it was considerable in one area, it was always present to some extent in the other.

*The President* thanked Miss Bonnar for a most enjoyable paper. It was very nice having her with them again. He hoped it would not be long before she came back with a third instalment. He had heard rumours that there was one on the way.

He also thanked Miss Clinch for opening the discussion, and all those who had taken part in it.

# SUBMERGED FIRST PERMANENT MOLARS

By **M. L. BRENCHLEY**, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.)
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## CASE REPORT

J. B., a girl aged 11 years, was referred to hospital in September, 1958, because of the presence of three submerged first permanent molars $\left(\frac{6}{6}\middle|\frac{}{6}\right)$.

CLINICAL FEATURES.—On examination two depressions were seen in the right first permanent molar regions, at the bottom of which hard structures could be felt with a probe. The upper left second deciduous molar was partly submerged. The tip of the crown of a tooth was visible in the lower left second permanent molar region (*Fig.* 1).

On radiographic examination, the full complement of teeth in the developmental stage expected at the age of

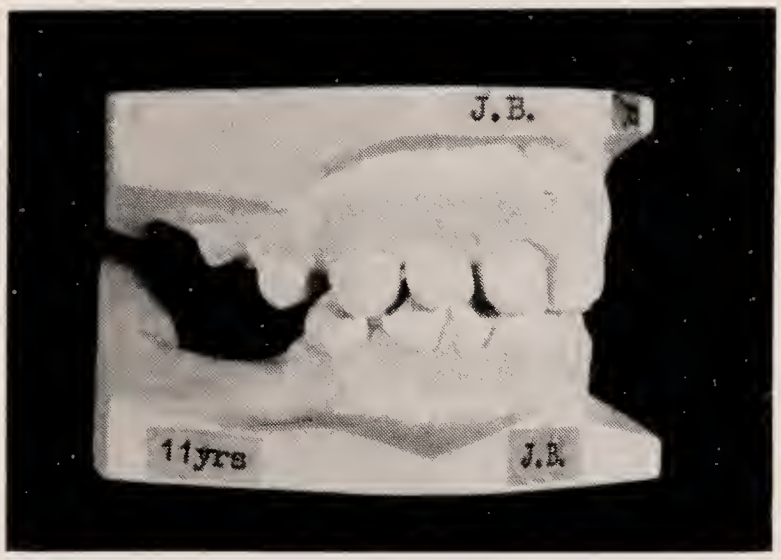
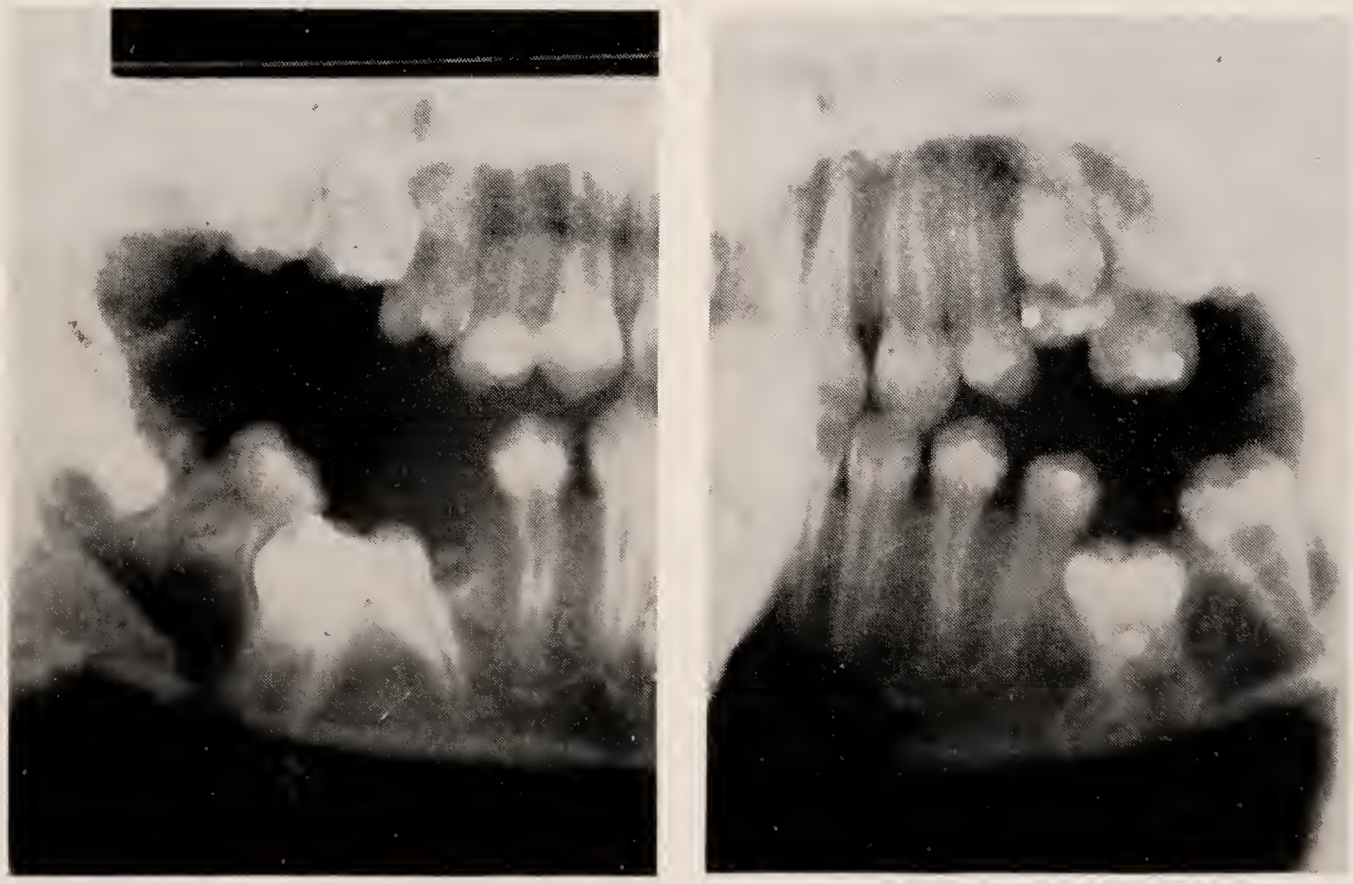


*Fig.* 1.—Models to show state of the dentition at 11 years. *Note* depression in $\frac{6}{6}\middle|\frac{}{6}$ region and submerged $\underline{|E}$.



A B

*Fig.* 2.—Pre-operative X-rays. Right and left sides.

A communication given at the meeting held on March 14, 1960.

11 years was demonstrated. The lower first permanent molars were present in an upright position with the occlusal surfaces of their crowns on a level with the superior surfacc of the alveolar process and their apices with the inferior border of the mandible. The upper right first permanent molar was present with its crown on the

*Fig.* 3.—Previous X-ray, 1956. Right side.

*Fig.* 4.—Post-operative X-ray of right side.

same horizontal level as the upper right second permanent molar. Occlusal fillings were present in the right first permanent molars (*Fig.* 2).

HISTORY.—It is known that the lower right first permanent molar erupted between November, 1954, and March, 1955, and was filled in April, 1955, and again in December, 1956. The upper right first permanent molar was filled in March, 1955, and again in November, 1956, when a note was made that it was beginning to submerge. It can be seen from the X-ray taken in December, 1956, that the right first permanent molars were then only just visible in the mouth (*Fig.* 3).

TREATMENT.—Surgical removal of the three submerged first permanent molars and the upper left second deciduous molar was advocated. This decision was made due to the possibility of caries attacking the submerged teeth, two definitely being open to the mouth and the other possibly by an undetected sinus. The consequent pulpitis and possible abscess formation would precipitate a difficult extraction as an emergency (Glass, 1951). At a later date surgery would be more difficult and there would be less chance of the remaining dentition adjusting itself (with or without the aid of orthodontic treatment).

The right first permanent molars were removed surgically under general anæsthetic, and this necessitated the extraction of the lower right second premolar. There were no signs of ankylosis of the roots, and the healing was uneventful (*Figs.* 4, 5). The lower left first permanent molar and the upper left second deciduous molar were removed at a later date. There was no loss of sensation in the lower lip.

## EXPLANATION OF CONDITION

From the fact that the apices of the lower right first permanent molar are so near the lower border of the mandible, it must be

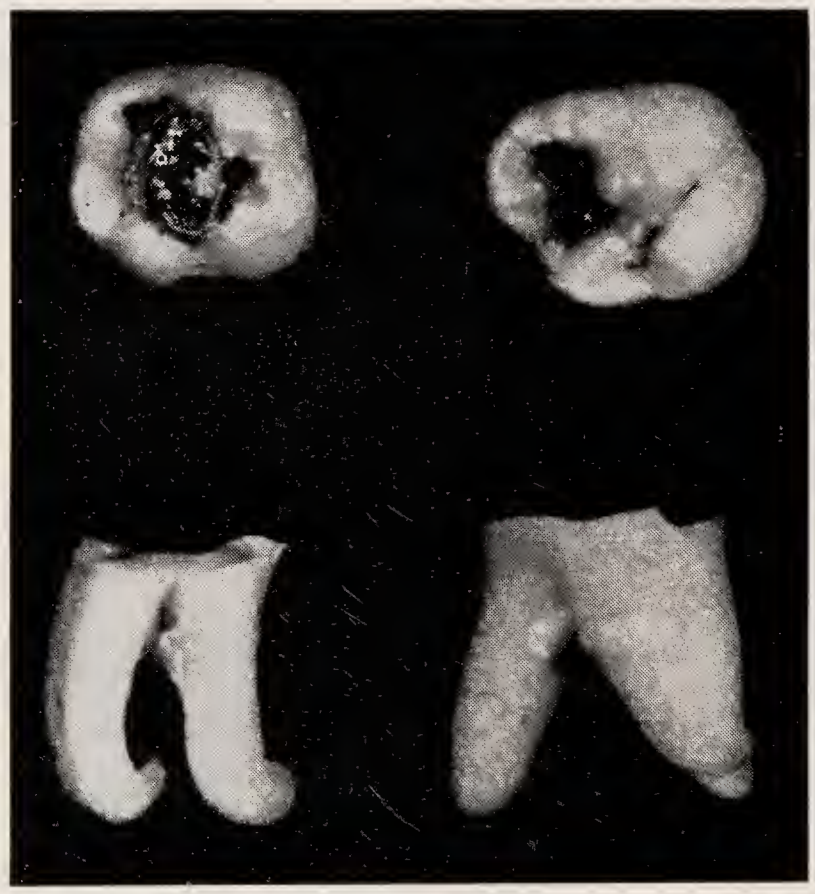


*Fig.* 5.—$\frac{6}{6}$| surgically removed.

assumed that the right first permanent molars began to erupt but never came into occlusion. Instead, they lost the ability to complete eruption but remained visible in the mouth for some 2 years until the alveolar process developed around the "inert" teeth. From a diagram showing a tracing of a radiograph of a normal dentition at $5\frac{1}{2}$ years, it can be seen that if the tooth suddenly became inert and ceased to rise occlusally, continued root development would result in the apices being in close relationship to the lower border (*Fig.* 8).

It is interesting to note the degree of distal tilting of the lower right second premolar

which had not erupted. It would appear in the X-ray of December, 1956 (*Fig.* 3), that there is a small fragment (probably of lower right second deciduous molar) in contact with

*Fig.* 6.—Tracing of a X-ray of the "normal" position of $\overline{6|6}$ in a child aged $5\frac{1}{2}$ years.

the mesial surface of the lower right second premolar crown. In the recent X-rays this fragment can still be seen but is now surrounded by alveolar bone (*Figs.* 2 A, 4). It would appear that the lower right second premolar may have become impacted between the lower right first permanent molar and the fragment.

Such examples of arrest of occlusal rise of teeth offer an interesting dated measure of alveolar development (*Figs.* 2 A, 3). It is also interesting to note that the apices of the lower first permanent molars are hooked (*Fig.* 5). It would appear that though the teeth presumably became "inert" when close to the lower border of the mandible, the roots continued to develop and did so in a distorted manner on reaching the cortical layer of bone at the lower border of the mandible.

## CONCLUSION

It would appear that this condition is of local cause and can be independent of the actual degree of eruption of the tooth concerned since it may commence at varying stages of eruption (Visick, 1944).

This lack of "erupting-power" may be due to ankylosis of the roots of the tooth, as it is believed to occur in deciduous teeth that submerge (but no evidence of ankylosis of these three first permanent molars was present in this case), or to a similar defect to that which is found in such rare conditions as cleidocranial dysostosis, only to a localized degree.

Finally the causative factor may conceivably be of phasic nature, but the resulting "secondary-impaction" by tilting adjacent teeth, augmented by the distorted nature of the apices, would tend to maintain the condition. Such a possibility was described by Dixon, 1959. The first permanent molar becomes impacted against the second deciduous molar, and fails to erupt when the deciduous tooth is shed, allowing the second premolar and second permanent molar to erupt past it, and to reimpact it.

**Acknowledgements.**—I would like to extend my thanks to Mr. W. J. Tulley and Mr. B. E. Cooke for their help and advice, and to Mr. K. E. Pringle and Mr. A. E. Croke for permission to use this material, and to the photographic department at Guy's Hospital for preparing the photographs and slides.

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## *DISCUSSION*

*The President* thanked Mr. Brenchley for a most interesting paper. He said that this was a very obscure subject and he was sure there were many members who would like to discuss the paper. He could remember one case which had a very strong family history on the mother's side, and there again, whatever one did, there was no result; but it affected not only the sixes but also the sevens on one side. It had been said that if they were loosened slightly, they might erupt, but he thought that had been tried, with no success at all.

*Mr. H. E. Wilson* said that he could report a similar occurrence in a family of two children, a boy 8 or 9 years old and a girl 12 or 13 years old, who had both deciduous and permanent molars ankylosed. The mother had an impacted first permanent molar removed a few years earlier. The X-ray of this showed a typical ankylosed first molar. One child had treatment on one side to bring the molars into occlusion, but this was unsuccessful. Treatment was discontinued, but the patients are kept under observation and the time approaches when they probably will have their first permanent molars extracted, which appears to be the only treatment. He had nothing else to add, the aetiology of ankylosis in the permanent dentition being a closed book to him.

*Mr. D. F. Glass* wished to thank Mr. Brenchley for a very interesting communication, which included some very good illustrations of submerged teeth.

He agreed with Mr. Brenchley that there was no association between this type of submerged tooth and that found in cleidocranial dysostosis. In cleidocranial

dysostosis the teeth were unerupted and had never been in contact with the oral cavity, whereas in all the submerged teeth seen by Mr. Glass there had been contact with the mouth and caries in some of the teeth.

He thought that with cleidocranial dysostosis the unerupted teeth should not be removed unless they were causing pain, whereas the true submerged tooth should always be removed, as the connexion with the oral cavity caused infection to the tooth and the area surrounding the tooth.

*Mr. Huddart* thanked the speaker for a very interesting observation on a rather obscure subject. He himself had had one of these cases some years ago. This was a distally inclined $\overline{6|}$ which was impacted against the mesial aspect of a mesially inclined $\overline{7|}$. The $\overline{6|}$ was almost completely covered with mucosa except for the mesial surface which was facing upwards and forwards and was exposed to the mouth. Fortunately the $\overline{5|}$ was rather hypoplastic so this tooth could be taken out with a clear conscience. The $\overline{6|}$ was exposed as much as possible by cutting away the overlying mucosa and then a mesial Class II gold inlay was constructed in the tooth. This inlay had a hook on its mesial aspect and elastic traction was used to pull the first permanent molar from underneath $\overline{7|}$. In this way the tooth was uprighted and practically brought into occlusion, but at that stage Mr. Huddart said he left the department where he was treating the case and that was the last he saw of it. He thought it might be interesting to know that there was hope for some of these cases.

*Mr. D. T. Hartley* said he could finish Mr. Huddart's story. The lower molar had, unfortunately, failed to reach occlusion. They had considered placing an onlay to bring it into functional contact with the opposing teeth, but eventually decided against this. He thought that the orthodontic movement achieved had been essentially an uprighting of the molar, which originally had a severe distal inclination. In comparison with this any vertical movement was probably quite small.

*Mr. Brenchley* said that he had been interested to hear what everyone had said; that these teeth, since they began to erupt, and did not completely erupt, were more prone to caries than teeth that had never come through. As far as moving them was concerned, he had read of cases where it had been attempted without success.

# SERIAL MODELS ILLUSTRATING SOME SPONTANEOUS CHANGES IN THE DECIDUOUS DENTITION

By **B. C. LEIGHTON**, L.D.S., D.Orth. R.C.S., H.D.D., D.D.O.
*King's College Hospital Dental School*

ALTHOUGH mueh has been written in support of the thesis that the pattern of development of the mastieatory apparatus is determined at an early age, this is by no means the ease when oeelusion, one of the manifestations of this development, is studied. A eertain degree of flexibility is permitted in the early stages by adjustments to the path of elosure of the mandible and by migration of individual teeth within the alveolar proeesses.

In 1908 Chapman reported his observation that although the distal surfaees of the upper and lower seeond deeiduous molars were frequently in the same vertieal plane before the age of 3 years, this relationship may be improved by forward movement of the lower molars relative to their opponents by 6 years. The ehange was said to be assoeiated with a greater inerease of upper areh width and a deerease of the ineisor overbite, whieh was eonsidered by Friel to be neeessary to faeilitate this movement. More reeently Bonnar (1956), in a serial study of 60 ehildren, found that in some eases spontaneous improvement of a postnormal oeelusion may oeeur either at the time of eruption of the seeond deeiduous molars, the first permanent molars, or the permanent ineisors. No mention has been made, however, of eases showing other ehanges of areh relationship.

In a series of 212 eases it was found that deterioration of oeelusion oeeurred as

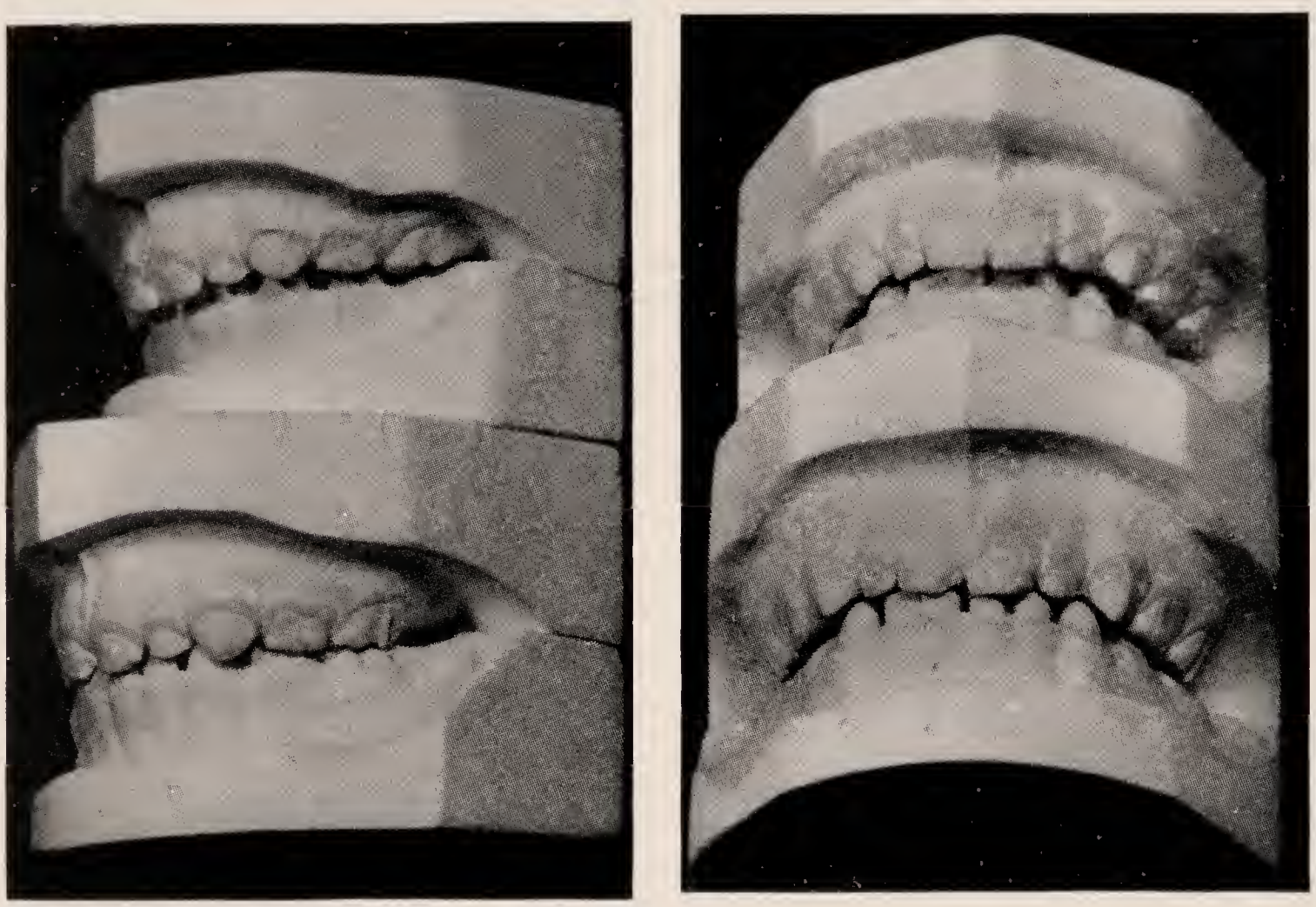

*Fig.* 1.—*Case* 271 in whieh postnormality and buccal oeelusion of the deeiduous molars of the left side improved spontaneously. Models taken at $2\frac{1}{2}$ and $3\frac{1}{2}$ years.

A demonstration given at the meeting held on May 9, 1960.

frequently as did improvement (*see Table I* and *Figs.* 1–3). Forty cases exhibited some alteration of occlusion between the third and fourth year. The incidence of changes which may be equally for better or worse suggests that

*Fig.* 2.—Models of *Case* 411 in which the molar occlusion became postnormal. Models taken at 2 years 5 months and $3\frac{1}{2}$ years.

these are not usually part of a developmental pattern, but rather chance manifestations of the effect of environment on the occlusion of the teeth. Little evidence could be found among them, however, to indicate that the changes were associated with sucking habits, swallowing behaviour, or the relationship of soft tissues to the teeth.

Both Wallace (1927) and Logan (1952) have drawn attention to the importance of the intercuspal guidance of the first permanent molars at the time of their eruption in establishing a normal anteroposterior relationship. Wallace dismisses as negligible any similar effect of the deciduous molars on the grounds that their cusps are insufficiently well marked. Examination of these teeth at the time of their eruption, however, shows them to have well-marked and sharp cusps, which soon become worn down. The possibility that the engaging of these cusps as they come into occlusion may at times influence the path of closure, and hence the occlusion of the other teeth, cannot be overlooked. It has been found that the relationship of opposing teeth to each other before they establish contact is often rather inexact. Examples of this may be found in the slight buccal occlusion often shown by the

*Table I.*—Frequency Distribution of 40 Cases where a Change of Anteroposterior Occlusion occurred between $2\frac{1}{2}$ and $3\frac{1}{2}$ years

| *Change of Occlusion* | *No. of Cases* |
|---|---|
| Normal to postnormal | 17 |
| Increasing postnormality | 6 |
| Decreasing postnormality | 3 |
| Postnormal to normal | 11 |
| Prenormal to normal | 3 |
| Total | 40 |

upper first deciduous molars soon after their eruption (*Fig.* 4), and the cusp-to-cusp relationship seen in the case of the second deciduous molars (*Fig.* 5). In the majority of cases the teeth become guided to a more normal occlusion by the musculature and by the inclined planes of the cusps. It is conceivable that at times the occlusion may be sufficiently uncomfortable, or a slightly premature contact of cusps may occur to cause a change in the path of closure of the mandible. The resulting change of occlusion may become established, or may revert after attrition has worn off the offending cusps. An extreme degree of this is illustrated in *Fig.* 1; in this case a buccal occlusion of the upper molars on the left side developed at the time of the eruption of the first molars. This was associated with postnormal occlusion. While it is not possible to say with certainty whether the path of closure was normal at this stage, the dramatic subsequent improvement of the postnormality and buccal occlusion suggest that the path of closure had become restored to normal.

In 18 of the 40 cases the second deciduous molars were found to have been in occlusion at $2\frac{1}{2}$ years of age, that is, before the changes of occlusion occurred. To ascertain whether this proportion was unduly high, a random 1 in 5 sample of the author's cases was examined; of 42 cases 21 were found to have had the second

deciduous molars in occlusion by $2\frac{1}{2}$ years. It would appear, therefore, that there is not always a close association between changes of occlusion and the eruption of the second deciduous molars. However, in most cases some evidence was found of adjustments of mandibular position when the teeth were in occlusion. This was manifested as alterations in the relationship of the centre lines of the two arches; this occurred in 13 out of 17 cases which

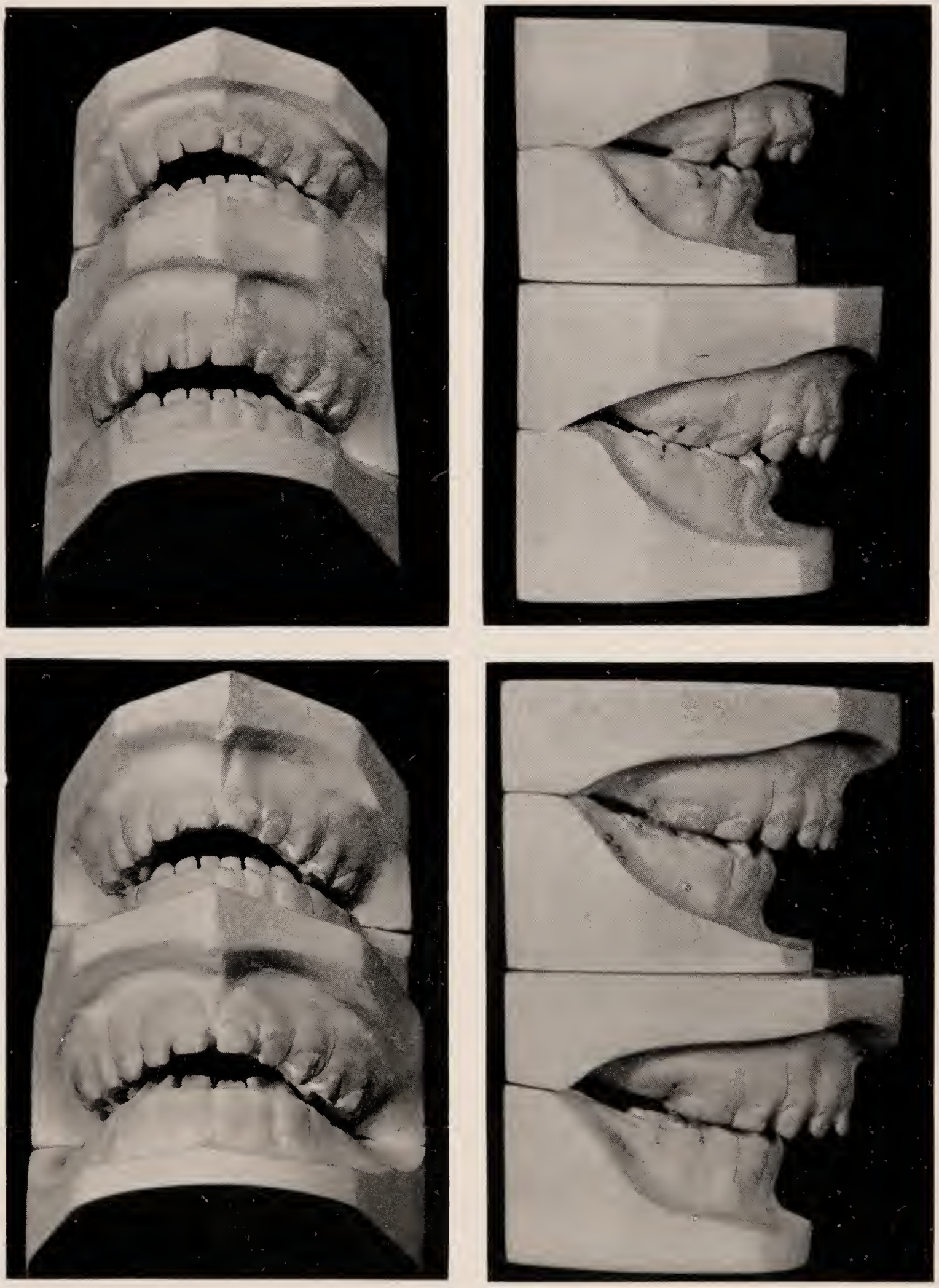

*Fig.* 3.—Models of *Case* 390 in which the molar occlusion became more postnormal, and a bilateral buccal occlusion developed. Models taken at 2 years 7 months, 3 years 7 months, $4\frac{1}{2}$ years, and $6\frac{1}{2}$ years.

improved, and in 17 out of 23 cases which deteriorated. Of thc cases which improved

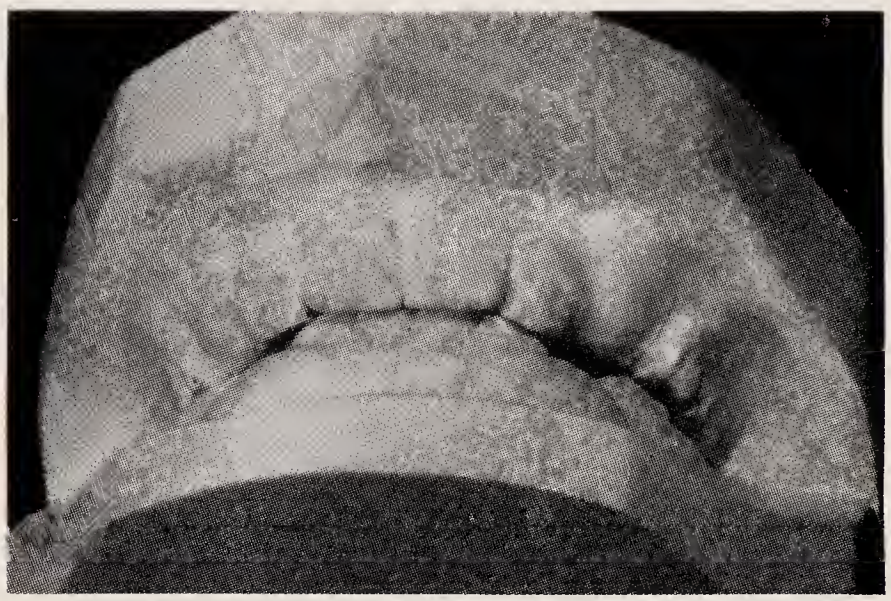

*Fig.* 4.—Models of *Case* 636 to show slight buccal occlusion of upper first deciduous molars, soon after their eruption. Model taken at 1 year 3 months.

(*Fig.* 3). Of all the 40 cases only 5 appeared to have a comfortably interlocking occlusion of the molars at $2\frac{1}{2}$ years. These were all normal cases which deteriorated; none of them swallowed with the teeth together, 3 still indulged in sucking habits, and 4 had not the second deciduous molars in occlusion by $2\frac{1}{2}$ years.

It is suggested that the changes of relationship which take place spontaneously are usually readjustments of an uncomfortable occlusion. In some cases this may be stimulated by the eruption of the second deciduous molars and subsequent closure of molar spacing. It appears that environmental factors may only occasionally bring about these changes.

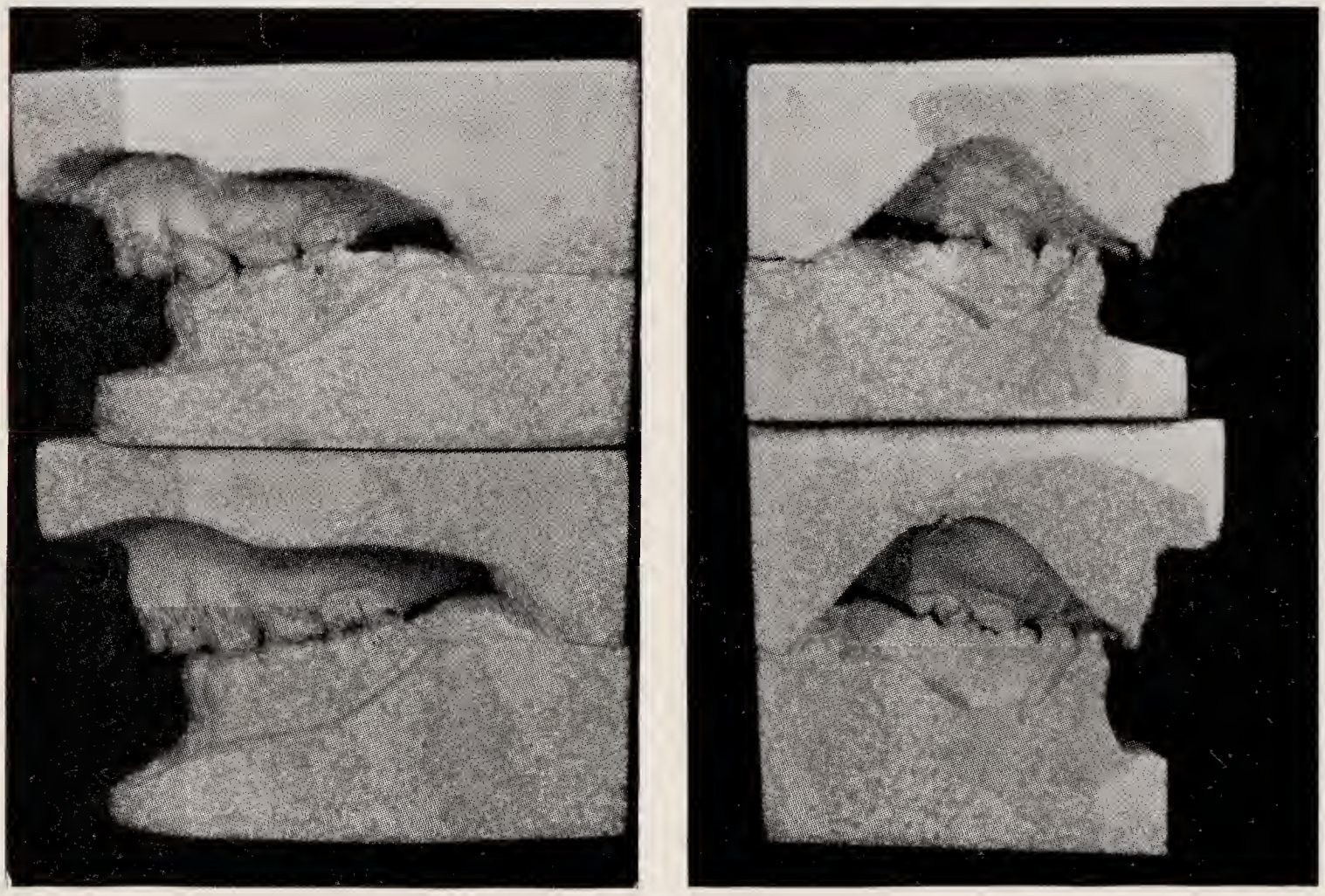

*Fig.* 5.—Models of *Case* 199 taken at $2\frac{1}{2}$ years and $3\frac{1}{2}$ years, to show the relationship of the second deciduous molars as they come into occlusion. Note the change of relationship of the lingual cusps and of the inclination of the lower molar.

anteroposteriorly, 1 acquired a cross-bite, 2 lost a cross-bite, and 2 lost a buccal occlusion. In 4 cases which deteriorated a lingual inclination of the upper incisors developed, and a further case acquired a buccal occlusion

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# COMMON FAULTS WITH REMOVABLE APPLIANCES

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THE importance of making orthodontic appliances wearable is all too frequently forgotten.

A removable appliance of basically good design is often unsatisfactory because some small point has been overlooked during its construction, and it is not to be assumed that a patient is unco-operative simply because the plate is not worn. Painstaking attention to small details is essential if an orthodontist is to make his appliances wearable.

*Fig.* 1.—Pimple on fitting surface of plate.

*Fig.* 1 shows an appliance with a large pimple on the fitting surface. This plate has been shown to many orthodontists and their criticism invited, but so far nobody has noticed the fault, although it makes the plate completely unwearable.

Three main factors contribute to the wearability of an appliance: (1) Simplicity; (2) Comfort; (3) Discreetness.

**1. Simplicity.**—Appliances should be as simple as possible, preferably with no more than two springs, otherwise the anchorage may be insufficient. In addition the patient may find himself unable to cope with the complex procedure of insertion and will either insert it incorrectly or not at all.

*Fig.* 2 shows an appliance which was in the pocket of a patient referred with a history of non co-operation. Apart from having five springs of various kinds, there were several sharp edges on the plate, retention and anchorage were poor, and the multiple buccal retractors were traumatizing the mucosa. The appliance was obviously too complicated for the patient to handle and was most uncomfortable to wear. It would have perhaps been more surprising if the patient *had* worn it.

*Fig.* 2.—Unwearable appliance, badly designed and poorly finished.

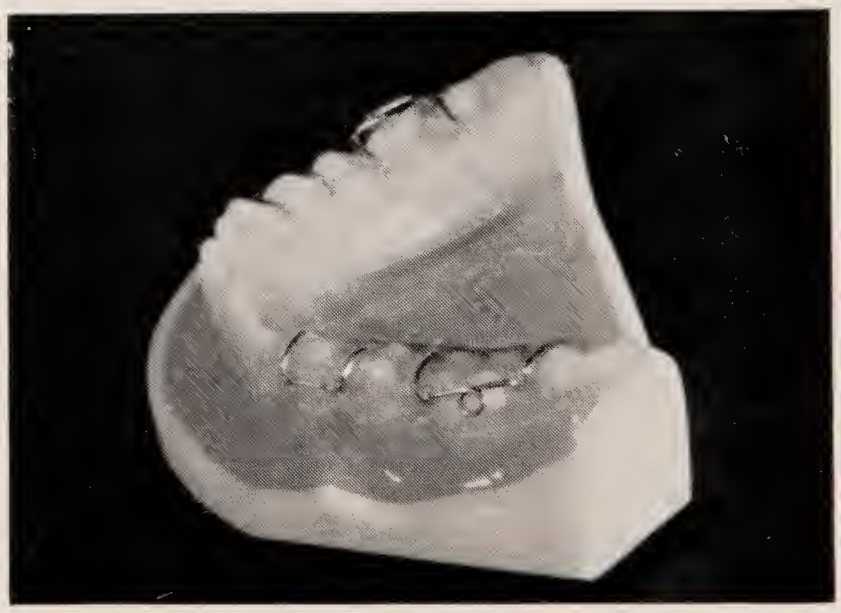

*Fig.* 3.—Lower removable appliance for intermaxillary reinforcement of the anchorage. Note absence of lower labial bow.

A demonstration given at the meeting held on May 9, 1960.

Another example of an awkward appliance to handle is the plate with a "Z" spring to move upper incisors labially. This can be most difficult for the younger patient below the age of 8 years to insert correctly, and usually an appliance with a Glenross or similar screw is preferable because of its simplicity. The greater bulk of the plate due to the screw is surprisingly well tolerated by these younger children, and usually no trouble is encountered because of it.

**2. Comfort.**—This may be subdivided into: (*a*) Security; (*b*) Painlessness.

*a. Security.*—This implies good retention for the appliance with well-made Adams cribs which are free of the bite and do not traumatize the gingivæ. The plate has also to be free of any tendency to spring out of the mouth and in certain cases (e.g., pusher spring to move upper incisors labially) great attention must be paid to clasping, often by utilizing premolar as well as molar teeth. Some authorities advocate the use of an inclined bite plane on an upper appliance to give intermaxillary reinforcement to the anchorage when upper teeth are being retracted. This, however, results in a forward displacement of the lower jaw on closure which some patients find unpleasant. To reduce an overbite, a small flat bite platform is preferable and if further anchorage is required a removable lower plate for intermaxillary traction should be used (*Fig.* 3). Excessive posterior gagging when upper incisors are being moved over the bite is also uncomfortable especially for the older patient, and a 1-mm. open bite anteriorly when the plate is in position is quite sufficient.

*b. Painlessness.*—It is extremely easy to make an appliance painful. Some of the commonest causes are:—

i. A rough, poorly finished fitting surface with sharp gingival margins and pimples.

ii. Buccal retractors which traumatize the mucosa. These springs are very vulnerable and often become distorted during use. In addition, if made in 0·7 mm. wire they need frequent adjustment. Although a more flexible buccal spring can be made from 0·5 mm. wire reinforced by 20 gauge (0·5 mm. internal diameter) tubing, the more trouble-free way of retracting canines and premolars is the 0·5 mm. palatal spring, which is covered and protected by acrylic to a great extent. The use of buccal retractors should be restricted where possible, therefore, to teeth which have to be moved distopalatally as opposed to directly distally.

iii. Sharp ends of springs and tubes can also lacerate the mucosa. Although the initial fitting may have been satisfactory, distortion during use may allow the sharp end of a wire to traumatize the mucosa. Some distortion of wires must always be expected with removable appliances, but intelligent anticipation should prevent the plate becoming painful as a result.

iv. High labial arches and apron springs, like buccal retractors, are a potential source of trouble due to distortion in use and should be avoided where possible. The Roberts retractor has been found to be more satisfactory when retracting incisors (*Fig.* 4). In addition it can also be used as a form of intermaxillary hook if desired, without any modification, should a lower traction plate be indicated to reinforce the upper anchorage.

v. Excessive spring pressure on a tooth must be avoided. A palatal finger spring in 0·5 mm. wire only needs about 2–2·5 mm. of activation for tooth movement to proceed smoothly, and it should take about 6 months to retract a canine or a premolar a full unit. If tooth movement is done more quickly than this, there is a danger that excessive tipping may occur. Usually such springs only need adjustment every 2 months. A tooth may be slightly tender up to 24 hours after adjustment, but apart from this it should remain firm and symptomless during movement.

**3. Discreetness.**—This is an often neglected aspect of appliance design, but it should be remembered that even children are human! Older patients, especially adolescent girls in their 'teens, are very sensitive about their appearance and are grateful for an inconspicuous appliance. Being less obvious, palatal finger springs should therefore again be used in preference to buccal retractors to move canines and premolars distally. Also, whilst some cases justify a stabilizing labial arch, there are many, particularly of the routine

Angle Class II, division 1 type, where it can be omitted.

*Fig.* 5 shows a plate to reduce the overbite and retract the upper canines which would hardly be suitable for the older patient. It has an inclined bite plane with buccal springs to retract $\underline{3|3}$ and a stabilizing labial arch.

*Fig.* 4.—Roberts retractor.

*Fig.* 6 is an alternative design, just as efficient in the average case but far less conspicuous and more pleasant to wear. This had a low flat bite platform, palatal springs. and no labial arch.

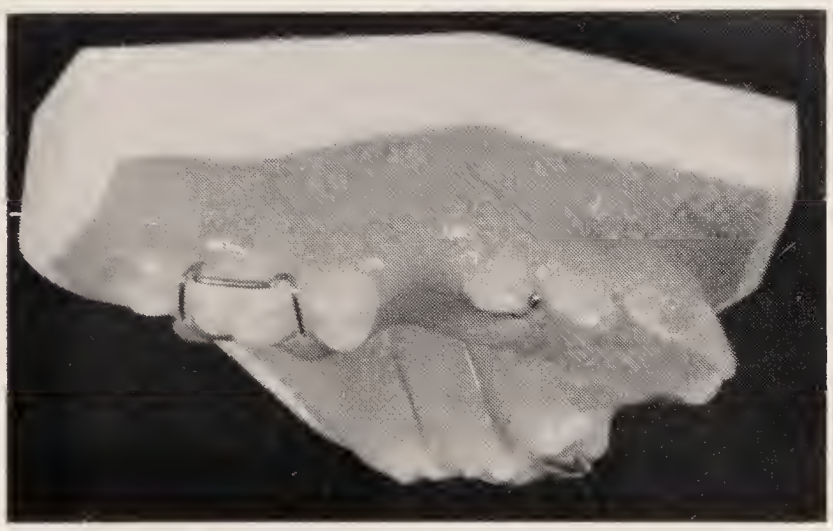

*Fig.* 6.—Alternative design. More comfortable and less obtrusive than *Fig.* 5.

The most inconspicuous way of retracting upper incisors is to use Paul's tubing, which is practically invisible when moistened with saliva. Care must be taken to prevent the elastic riding up the labial surfaces of the incisors and traumatizing the labial gingivæ, however, but in most cases it is possible to adjust the appliance satisfactorily in order to stop this. Paul's tubing is not quite so precise in its action as the Roberts arch, but where appearance is an important consideration it is a very satisfactory alternative.

When retracting upper incisors make sure that the plate is cut away completely behind the anterior teeth to prevent trapping of the mucosa in this region (*Fig.* 7). If this is not done, tooth movement may be prevented and the hypertrophy of mucosa which also results can be extremely painful.

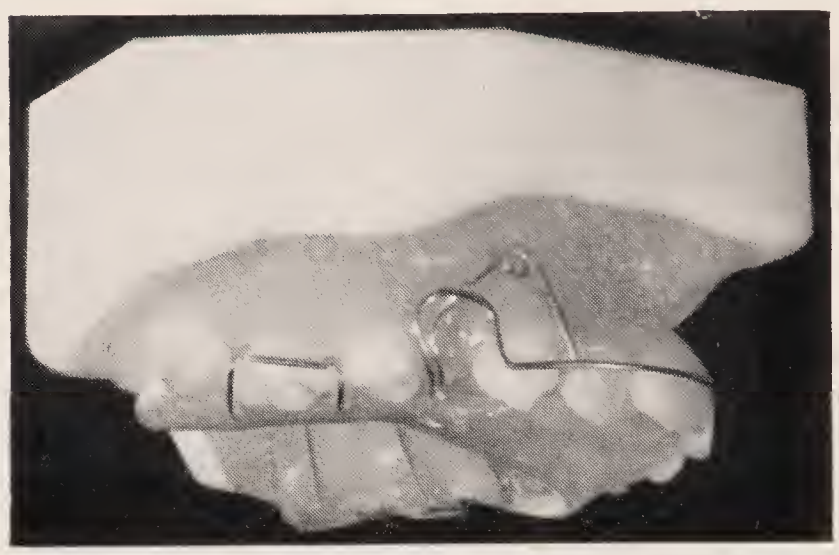

*Fig.* 5.—Appliance to retract upper canines with buccal retractors, labial bow, and inclined bite plane.

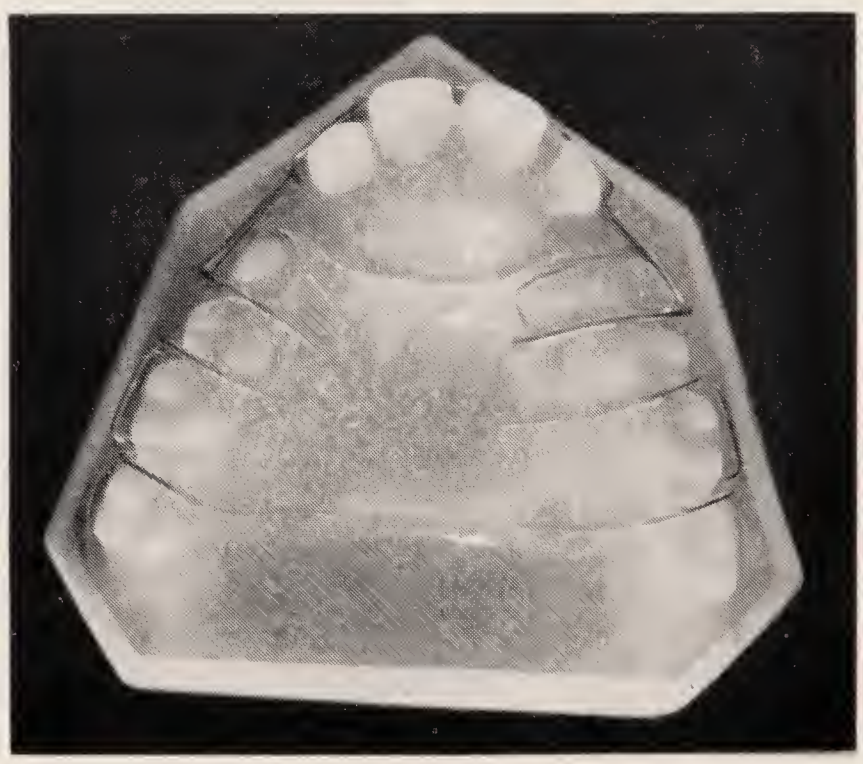

*Fig.* 7.—Plate cut well away palatally to allow retraction of $\underline{21|12}$.

Patients, however large or small, need a simple, comfortable, discreet appliance to wear, and by attention to detail it is possible in most cases to provide it. Given such an appliance and a patient who genuinely desires orthodontic treatment, there should be little trouble in seeing it is worn sufficiently to be effective.

At the demonstration meeting examples of appliances both correctly and incorrectly made were shown and some of them have been illustrated here.

# SIMPLE FIXED–REMOVABLE APPLIANCES FOR CANINE AND PREMOLAR ALINEMENT

By **J. C. STEPHENSON**, B.D.S., F.D.S., D.Orth. R.C.S.

Removable appliances, when used for the alinement of canines and premolars, cannot prevent the occasional appearance of rotations or tilting of the teeth concerned. In these cases the use of a full fixed appliance is the method of choice, but in addition to being a time-consuming procedure, this is often not possible for social and other reasons.

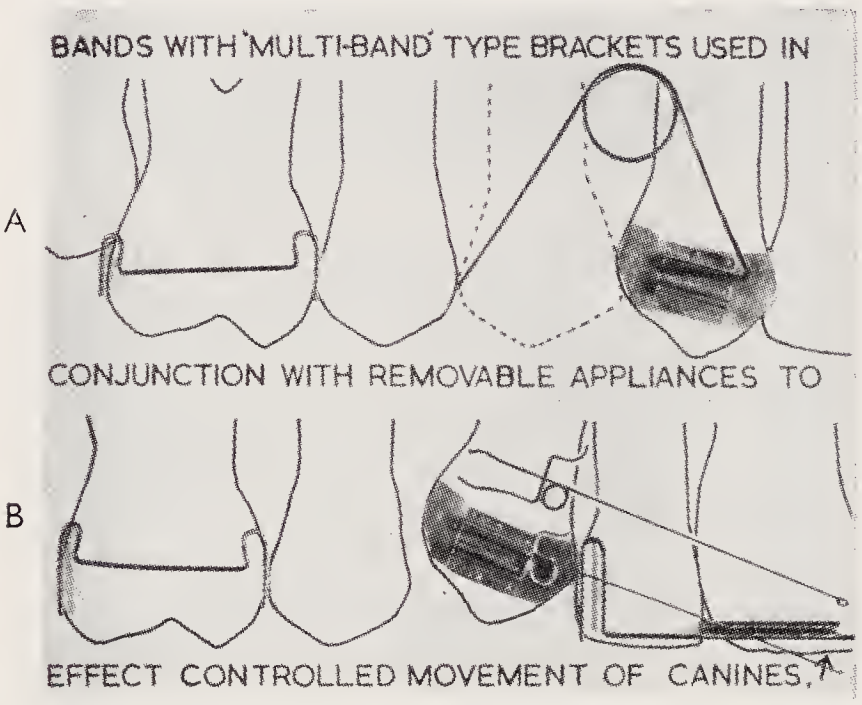


*Fig.* 1.—A, Adams's type (0·7 mm.) buccal canine retractor with end of spring thinned and bent to form a "spike", engaging one of the ligature tubes of the "multi-band" bracket, usually the more gingival one, to produce rotational or other movements in addition to retracting the tooth. B, Detachable "whip" in 0·45 mm. or 0·018 in. stainless steel wire with short piece of similar wire welded and soldered at right angles to it, and adapted to engage the two ligature tubes of a "multi-band" bracket on the canine. The patient activates the "whip" by "clicking" the the end of the arm into a piece of slit 0·9 mm. internal diameter tubing, attached to the labial arch.

The use of bands with standard multi-band type brackets in conjunction with removable appliances enables these tooth movements to be controlled, whilst a minimum of chairside time is involved in their construction and adaptation to individual teeth.

The first appliance (*Fig.* 1 A) was designed to prevent an upper canine rotation becoming worse during retraction of the tooth, but it was found possible to do not only this but also correct the rotation in the process. The buccal retractor spring was constructed in 0·7 mm. stainless steel wire and was of the type described by Adams (1957), but modified so that the end of the spring, instead of engaging on the mesial aspect of the tooth, was thinned and bent to form a spike which the patient placed within one of the ligature tubes of the bracket (usually the more gingival one). By adjusting the position and direction of the "spike" the spring could be activated to produce rotational and other movements in addition to retracting the tooth.

The second appliance (*Fig.* 1 B) was designed in the first instance to produce rotational and "eruptive" movements for final alinement of an upper canine that had been moved into the line of the arch from a displaced palatal position. As in so many of these cases the patient was older than the average, and after several months of appliance therapy which had moved the canine into the arch, the construction of a full fixed appliance to merely rotate and produce final "eruption" of the tooth would have been a very involved and time-consuming procedure.

The canine was accordingly banded and a "whip" constructed in 0·45 mm. stainless steel wire to be fitted into the bracket tubes. The construction of this "whip" involved the careful welding at right angles to the "whip" arm of a short piece of similar wire, and in order to give this union maximum strength the upper short arm was heated and hard solder allowed to flow down on to the union, care being taken to preserve the temper of the other three arms. Two of these arms were then adapted with a pair of fine spring-forming pliers so that they made a tight push-fit in the ligature tubes of the bracket. A loop was incorporated in the "whip" arm to increase its flexibility and also to vary the direction of

A demonstration given at the meeting held on May 9, 1960.

movement. The existing removable appliance was modified by soldering a short length of 0·9 mm. internal diameter tubing to the arch and slitting it anteriorly with a carborundum disk. Thus, when the "whip" was attached to the canine band, it could be activated to produce rotational and eruptive movements

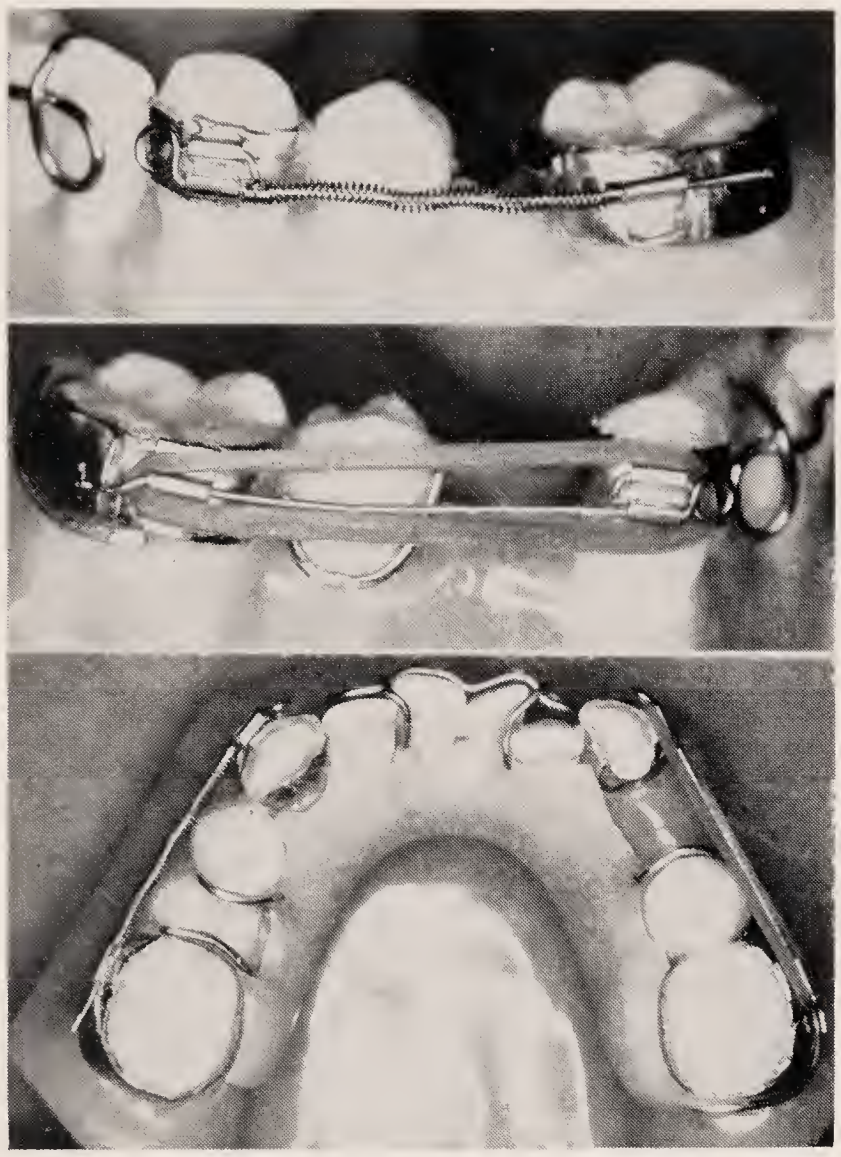


*Fig.* 2.—A, Sectional arch in 0·016 in. or 0·018 in. stainless steel or Elgiloy type alloy wire, one end forming a loop with two arms passing through the ligature tubes of a "multi-band" bracket on the canine, the longer arm also engaging the buccal sheath on the molar. A 0·7 × 0·15 mm. open stainless steel spring threaded on to the arch produces a suitable activation for space opening. The canine is shown banded in this illustration, but of course the first premolar might equally well be used. B, Similar sectional arch used in conjunction with No. 4 or No. 6 elastics to produce space closure following loss of lower premolar. C, Showing the use of a removable appliance to reinforce the anchorage when this is considered necessary.

by "clicking" the arm into position inside the slit tubing.

The fixed sectional appliances shown last involved the construction of canine (and/or premolar bands) and molar bands, in conjunction with palatal or lingual removable appliances to increase the anchorage potential where necessary. This method was found particularly suitable for those cases where a removable appliance was being inserted to commence movement in the opposing arch. and where it was desirable to start lower arch tooth movement as soon as possible, i.e., without having to await construction and fitting of all lower arch bands.

For example, as in the cases shown, recreating space for a lower second premolar (*Fig.* 2 A) and closing space following loss of a lower first premolar (*Fig.* 2 B), the construction and fitting of the necessary bands, sectional arches, etc., can be rapidly performed permitting an early start to active treatment. Should the anchorage prove inadequate, the appliance can be reinforced by a suitable removable appliance (*Fig.* 2 C), or, if necessary, by fitting of premolar and incisor bands so that the sectional arch "grows up" to become a full multi-band arch appliance.

The actual sectional arch is made of 0·016 in. or 0·018 in. stainless steel or Elgiloy type alloy wire, so that it has an adequate degree of flexibility whilst possessing the stability of a rectangular arch. The loop incorporated anteriorly permits adjustment to allow the two arms to pass easily through the ligature tubes of the canine or premolar bracket, and at the same time prevents it being a completely rigid joint. It can be used for looping elastics over for space closure or for holding the arch whilst feeding a space opening spring on to it, prior to passing the distal end through the molar buccal sheath. It is common practice to turn the free end of the shorter arm down to lock the arch and prevent it sliding out of the bracket. Most commonly No. 4 or No. 6 space-closing elastics are used, looped singly or doubled, whilst 0·7 × 0·15 mm. open stainless steel springs appear to provide a suitable range of activation for space opening.

**Acknowledgements.**—I wish to thank Professor C. F. Ballard of the Orthodontic Department, Eastman Dental Hospital, and Mr. W. A. Nicol, Consultant in Orthodontics to the Bristol Dental Hospital, for their help and permission to publish these appliances; also

Mr. F. D. Godman, of the University of Bristol Medical Photographic Department, for the illustrations.

REFERENCE

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# A COIL SPRING RETRACTOR FOR REMOVABLE APPLIANCES

By **J. W. SOFTLEY**, B.D.S., F.D.S., D.Orth. R.C.S.

THE retraction of upper canines is one of the more common movements required in orthodontic practice. Removable appliances are particularly suitable for the purpose as anchorage problems are more easily overcome by taking advantage of the slope of the palate and by using an anterior guide plane.

However, the springs in general use so far are often difficult to adjust or require frequent adjustment, and some are easily distorted.

The coil spring provides a source of even pressure over a long range, and the appliance described is easily inserted and robust enough to withstand ordinary usage.

The pressure is exerted by a traveller activated by a coil spring. Rotation of the traveller is prevented by a welded loop (*Figs.* 1, 2).

If both canines are to be moved the coil works reciprocally on both teeth. Where one tooth only is to be moved a friction stop is used as suggested by Johnson.

The appliance can readily be adapted for canines which are placed high in the alveolus (*Fig.* 3). It can, of course, be applied to other teeth.

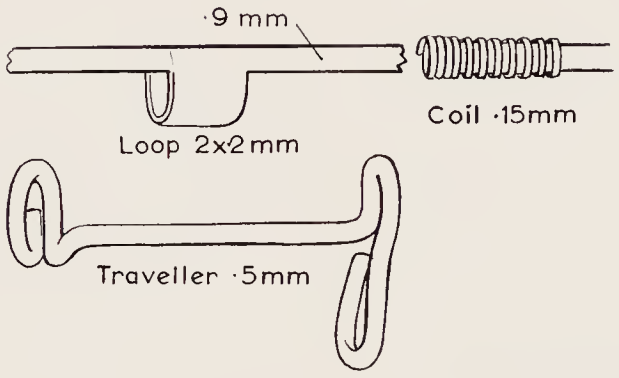


*Fig.* 1.—Diagram to show component parts of retractor.

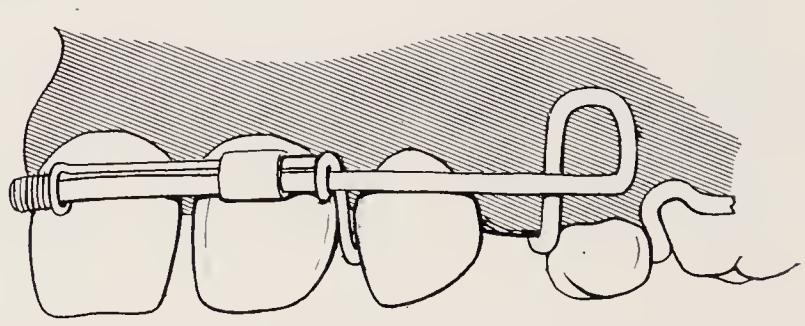

*Fig.* 2.—Retractor adapted for distal movement of $\underline{|3}$.

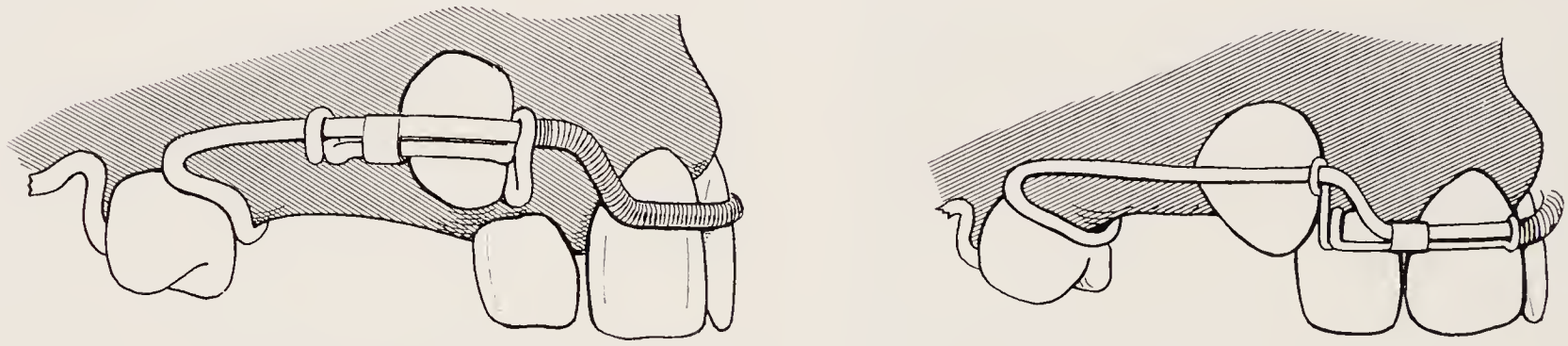

*Fig.* 3.—Alternative methods of adapting the appliance to highly placed teeth.

Practical points in construction are: Labial arch wire, 0·9 mm.; Coil spring, 0·15 mm. wound on 0·9 mm.; Traveller, 0·5 mm.; Welded loop, 2 × 0·2 mm.

The coil springs and travellers are assembled before processing, but it is convenient to add the loop when the plate is finished.

Friction stops must be added to the labial arch before bending.

The coil spring should not be extended at the ends.

**Acknowledgements.**—I am indebted to Miss M. C. McLarty, of the Radcliffe Infirmary, Oxford, for the drawings, and to Mr. Alan Grisdale for the demonstration models.

A demonstration given at the meeting held on May 9, 1960.

# THE ROUND-WIRE MULTIBAND APPLIANCE

By **C. P. BRIGGS**, B.D.S., F.D.S., D.D.O., D.Orth.
*Royal Dental Hospital of London*

In presenting this demonstration no claims to original work are made, and those interested are referred to papers by Hill (1954a, b) and Begg (1954, 1956). It was felt, however, that various features of technique which have evolved in the past few years in the Orthodontic Department of the Royal Dental Hospital would be of interest to the Society.

Taking a typical Angle Class II, division 1 case as an example, the technique consists first of a full band up after the extraction of all four first premolars, followed by the fitting of a light aligning arch. This has usually been of 0·018 in. high-tensile wire, but now, as better wire is becoming available, light arches of 0·014 in. are fitted. The purpose of this arch is to align the band brackets, so that heavier arches, fitted later, are able to slide freely along the buccal segments.

With a case not showing too severe imbrication, this fine arch may be replaced with a 0·020 in. working arch, or a 0·018 in. high-tensile arch if of sufficient hardness, within 2 or 3 weeks. The thinner arch is preferable, as frictional resistance in the buccal tubes is reduced.

Elastic bands are fitted to retract the upper canines, using inter-arch traction. The teeth posterior to the extraction space in the lower arch are used as anchorage for this movement (*Fig.* 1).

Intra-arch traction in the lower arch to retract crowded canines is often desirable (*Fig.* 2); this may also be used to prevent

*Fig.* 1.—Elastic inter-arch traction, retracting upper canine and using teeth posterior to extraction space in the lower arch as anchorage.

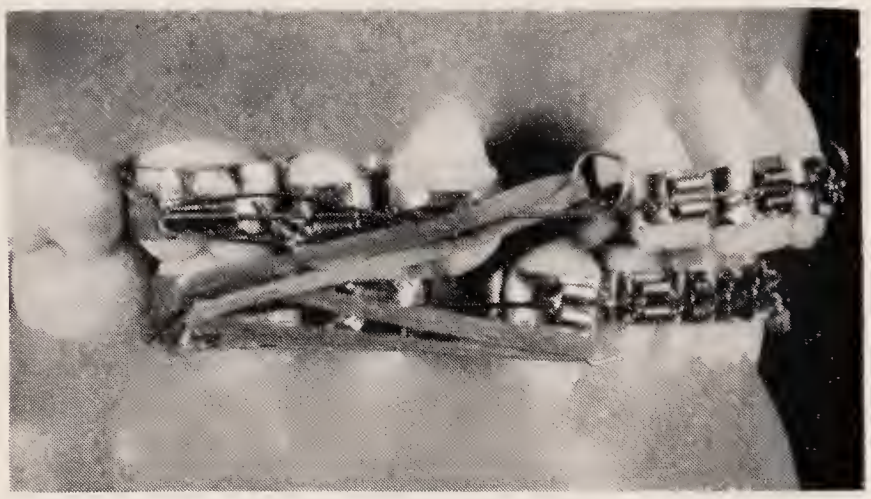

*Fig.* 2.—Inter- and intra-arch traction proceeding simultaneously.

*Fig.* 3.—Inter-arch traction retracting upper incisors and closing residual extraction space in the lower arch.

*Fig.* 4.—"Kick out" bends medial to canines.

A demonstration given at the meeting held on May 9, 1960.

proclination of the lower incisors out of muscle balance. In this instance, traction loops are incorporated in the arch wire medial to the canines.

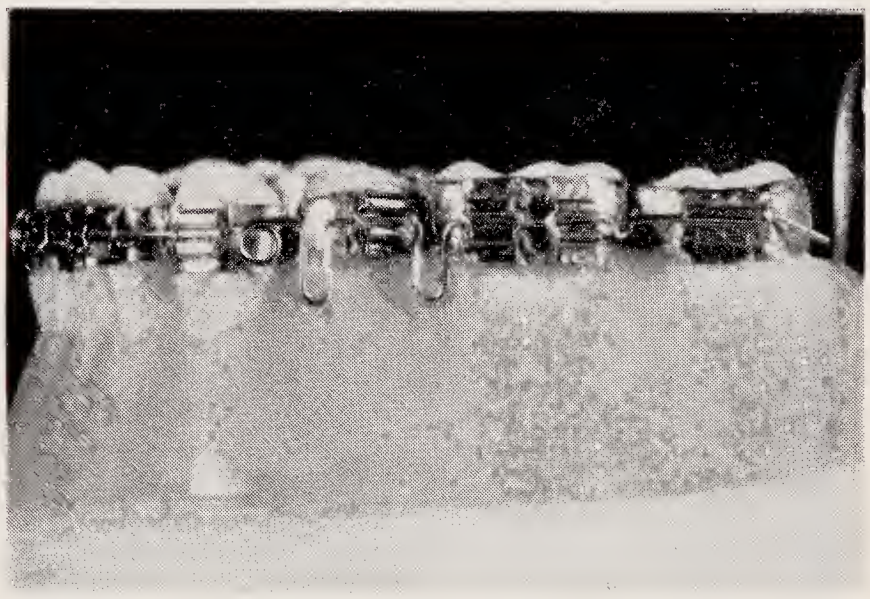

*Fig.* 5.—"Third-power" bends increasing local flexibility and allowing alinement of premolar.

*Fig.* 6.—"Whip", constructed of 0·018 in. high-tensile steel placed in tie bracket of lower right premolar and hooked on to main arch in incisor region.

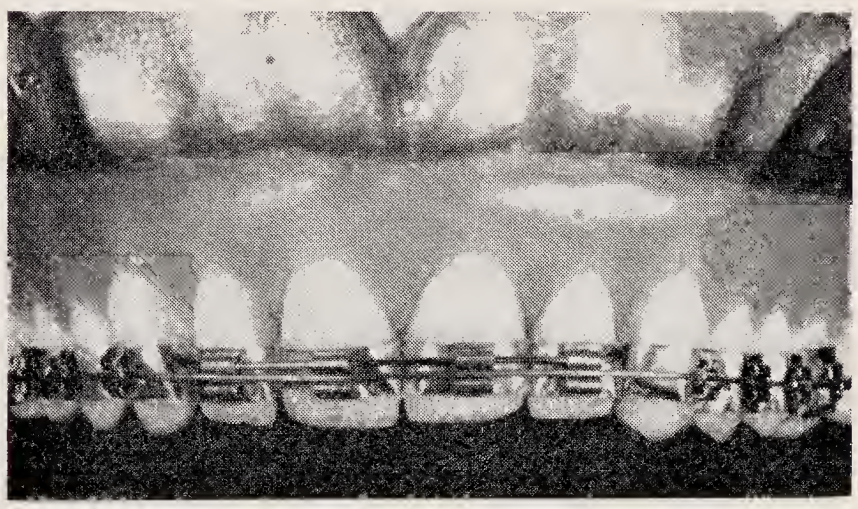

*Fig.* 7.—Accessory arch in tie brackets achieving final alinement of incisors.

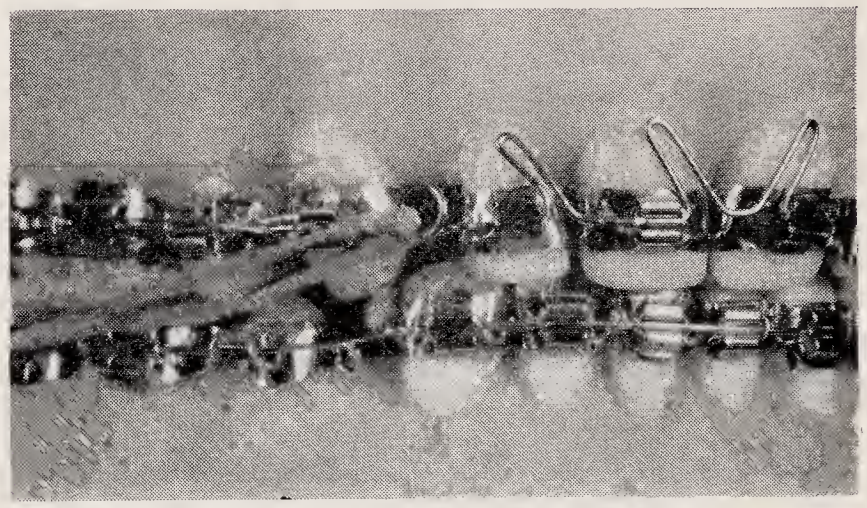

*Fig.* 8.—"Begg" type arch with gingival loops.

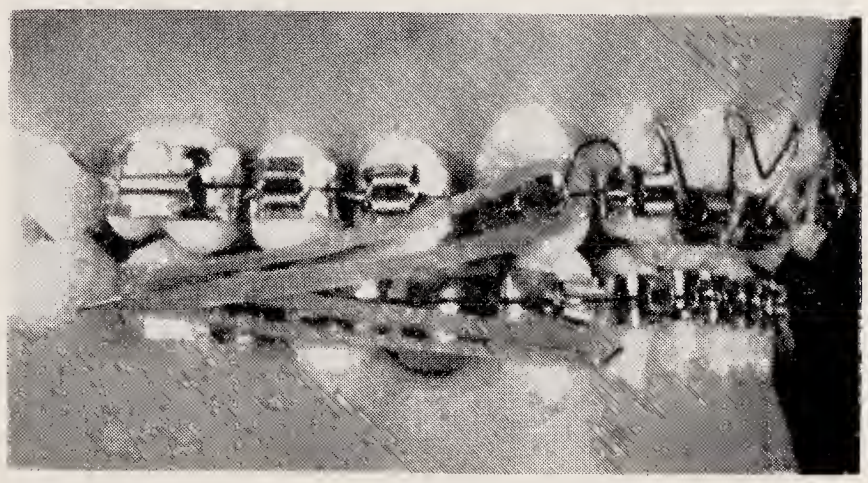

*Fig.* 9.—Inter- and intra-arch traction on "Begg" type arch.

Following retraction of the canines, the upper incisors are themselves retracted by means of an upper arch sliding freely in the buccal segment (*Fig.* 3). The importance of a "kick out" bend medial to the canine (*Fig.* 4) to allow for this movement is emphasized.

Final alinement is achieved by tightly ligating the brackets to a 0·022 in. final arch bent up to ideal arch shape.

Various accessories and modifications are in common use, and some are shown. Where it is desired to move teeth across the line of the arch, to correct a minor rotation, or to achieve a depression, "third-power" bends are incorporated in the main arch wire (*Fig.* 5). For the correction of more severe rotations, a "whip" in 0·018 in. wire is suitable (*Fig.* 6).

To achieve a final alinement of root apices, accessory arches of successively increasing diameter may be inserted into the tie brackets (*Fig.* 7).

In treating a Class II, division 2, where palatal movement of upper incisor apices is desired, a "Begg" type arch is fitted. This arch has loops which extend apically from the bracket to impinge on the tooth in the region of the gingival margin (*Fig.* 8). These loops are activated by closing up the traction loop in the

eanine region. Inter-areh traction (*Fig.* 9) is an essential feature of this appliance, and extra-oral anchorage to reinforee at night time is desirable, otherwise proelination of the ineisor erown, rather than retroelination of the apiees, will oecur.

**Acknowledgements.**—I wish to thank my colleagues in the Orthodontic Department of the Royal Dental Hospital for their adviee and assistanee in preparing this demonstration, and Messrs. E. D. MeBride and J. Shilland for models and photographs.

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— — (1954b), *Ibid.*, **5**, 52.
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— — (1956), *Ibid.*, **42**, 481.

# SOME ORTHODONTIC SPRINGS

By **P. H. BURKE**, B.D.S., H.D.D., D.D.O.

## CANINE RETRACTION SPRING

This spring is partieularly indieated for the retraction and alinement of buceally displaeed maxillary and mandibular eanine teeth (*Fig.* 1). It is mounted in a modified "U-loop" on a labial bow by wrapping only (*a*). The spring is essentially an auxiliary finger spring (with loop) attached to a labial bow which ean be displaced distally to supplement the normal range of aetion of a finger spring. The distal displaeement is achieved by extending the five or six loosely wound loops on the horizontal bar of the "U-loop" of the labial bow (*b*). The spring is extended to engage the mesial surfaee as its point of applieation, and its aetion is guided by a looscly wound runner (*c*). This is also a safeguard should the spring break. The range of the runner is increased by the mesial tilt of the distal arm of the "U-loop" in the labial bow (*d*). Stainless steel wire of 0·45 mm. diameter provides a suitable foree for tooth movement. Although bueeal displaeement furnishes an easy point of applieation for the spring on the flat mesial surfaee of the eanine tooth, it ean be used to retraet teeth in alinement and teeth other than eanines (*Figs.* 2, 3).

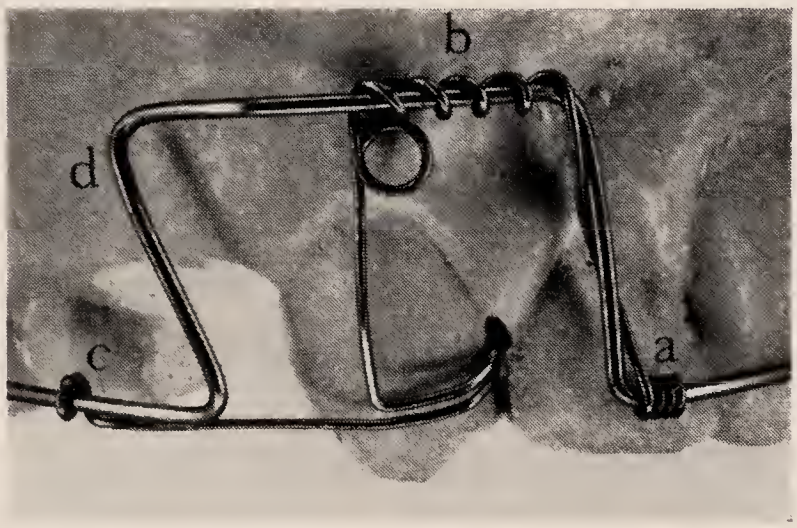


*Fig.* 1.—Canine retraction spring.

*Fig.* 2.—Spring in use retracting and alining maxillary canine.

*Fig.* 3.—Spring moving a central incisor distally.

A demonstration given at the meeting held on May 9, 1960.

## DOUBLE FINGER SPRING

In cleft palate patients access to the palatal surface of incisor teeth in linguoocclusion may be difficult. This is particularly so when there has been medial collapse of the buccal segment, which now comes to lie directly palatal to the incisor adjacent to the cleft. A "boxed-in" finger spring attached away from the area of collapse is the obvious solution. A double boxed-in finger spring with loops gives security should the wire break, and favours the use of thinner wire with a smooth spring-end to help access. The loops are staggered for easy adjustment and the spring may have to be "cranked" more than is shown in the illustrated appliance (*Fig.* 4). Again 0·45 mm. stainless steel wire is used. Since the incisor adjacent to an alveolar cleft is often hypoplastic, strict attention should be paid to oral hygiene, particularly on the palatal aspect, when this spring is used.

*Fig.* 4.—Double finger spring to procline central incisor.

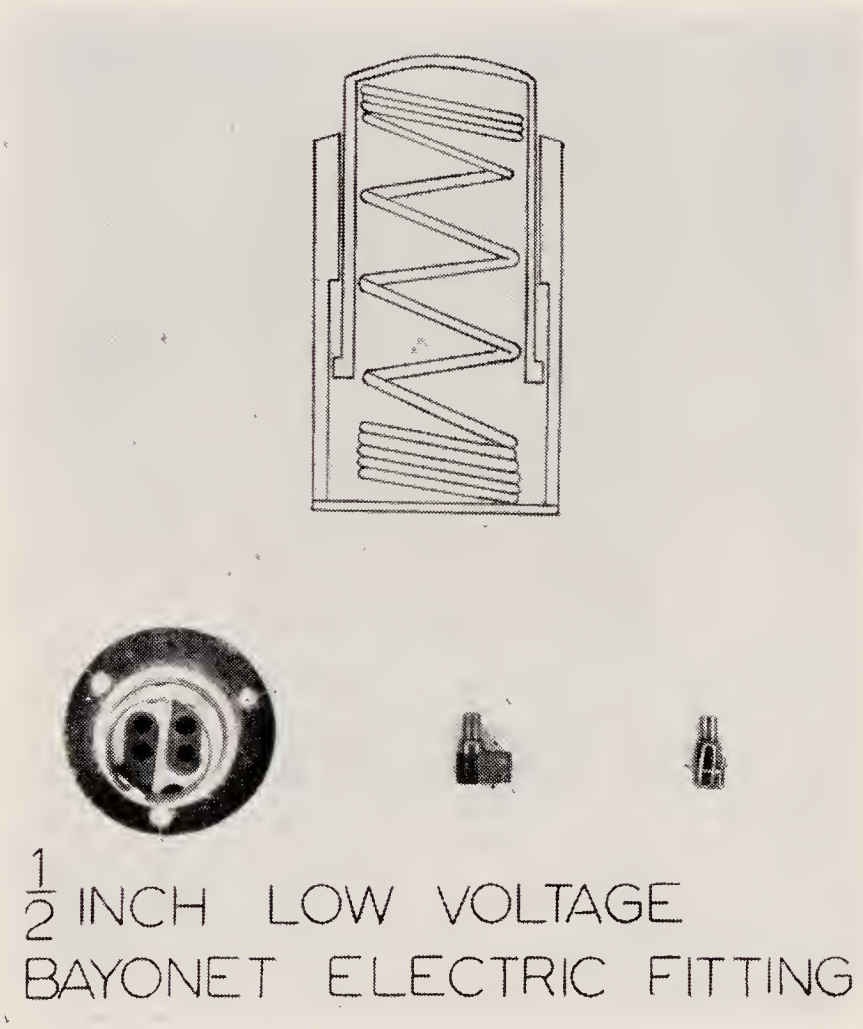


*Fig.* 5.—Plan of spring plunger.

## SPRING PLUNGER

The virtue of the coil spring is maximal range of action with minimal bulk. This spring may be used to procline an incisor in the form of a spring plunger (*Fig.* 5). A source of ready-made brass spring plungers is the standard half-inch low-voltage bayonet electric light fitting. After extracting the spring plunger from the fitting, the heavy coil spring is removed by drilling through the base. A suitable orthodontic coil spring in 0·015 or 0·02 mm. stainless steel wire is then inserted and a new brass base is secured using soft solder. The bulk of the base is reduced as much as possible leaving a small flange to prevent rotation when the spring plunger is attached to a suitable orthodontic appliance using quick setting acrylic resin (*Fig.* 6).

**Acknowledgements.**—I am indebted to Mr. J. Curran, Senior Dental Technician, Newcastle upon Tyne Dental Hospital, for his help in preparing some of the material for this demonstration. My thanks are also due to the Photographic Department of the Newcastle upon Tyne Dental Hospital for the care taken in producing the illustrations.

*Fig.* 6.—Removable appliance carrying spring plunger to procline a central incisor.

# THREE CASES SHOWING MARKED INCREASE IN MALOCCLUSION IN THE MAXILLARY INCISOR REGION

By **LILAH M. CLINCH**, M.A., F.D.S., D.Orth. R.C.S.

THE following cases may explain why an occasional patient does not respond to orthodontic treatment as the majority do; the development is becoming more unfavourable although there is no obvious reason to explain this sudden change for the worse. If appliances were fitted they would not only be correcting the malocclusion which is present, but also they would be battling against an unusual degree of lack of growth in one area in particular. All the children were healthy, well-grown girls whose medical history was good. One was a case which was under observation annually since 4 years of age; the other two were noticed by chance, as they were examined and impressions for reference models were taken, and then for family reasons they were not brought back for further treatment for about 2 years. The change for the worse during that period was so striking that it was difficult to believe that they were the same children. However, the rugæ formation, which appears to be like fingerprints and different in each individual, confirmed that the original models did belong to these patients.

The first illustration (*Fig.* 1) shows a case of good development of the dental arches over the same age period, that is, from the mixed to the permanent dentition. The contour of the alveolar bone in the maxillary incisor region remains full and the labial inclination of the teeth has altered very little, if at all. Forward and downward movement of the dental arch has taken place and the bone deposition anterior to the incisor roots has kept pace with this alteration in the arch position. The maxillary intercanine breadth at the lingual gum margin is 0·4 mm. less in the permanent dentition, due to the greater labiolingual thickness of the permanent canine; but the intercanine measurement taken from the point of the cusps is 1·5 mm. greater in the permanent arch.

The three following cases developed very differently.

## CASE REPORTS

*Case* 1 (*Fig.* 2).—First models were taken at 8 years 6 months. These show a well-formed maxillary arch, with a reasonable contour of the alveolus in the incisor area and no appreciable labial inclination of the incisor teeth. The second models were taken at 11 years 4 months. Four first premolars had been extracted 2 months previously. There has been a marked increase in the labial inclination of the maxillary incisors and an apparent hollowing over their roots. The occlusal views show the alteration in the conformation of the maxillary arch. It was not possible to measure the intercanine breadth accurately in the second model as one of the teeth had not fully erupted, but it is obvious that the arch has narrowed. The medical history during the period covered by the models showed that the child had had mumps during her eighth year and had had two attacks of tonsillitis. (The tonsils, however, were not removed.)

*Case* 2 (*Fig.* 3).—First models were taken at 9 years 8 months. These show a subnormal maxillary arch with medial drift and rotation of the first permanent molars after premature loss of the deciduous molars; there is a slight labial inclination of the central incisors, but the contour of the alveolus over the roots of the incisors is well formed. The second models were taken at 12 years 4 months; the maxillary first premolars had been extracted one month previously. There has been a marked increase in the labial inclination of the maxillary incisors and an apparent hollowing of the alveolus over the roots of these teeth. The occlusal views show the increase in imbrication in the maxillary incisor area. The intercanine breadth at the gum margin decreased by 1·3 mm., and the increase between the points of the cusps was only 0·2 mm. The medical history during the period showed no illnesses except occasional head colds and one severe attack of influenza.

*Case* 3 (*Fig.* 4).—First models were taken at 4 years. These show reasonably well-formed arches, with a tendency to postnormal occlusion of the mandibular arch. There is well-developed alveolar bone in the maxillary incisor region. The second models were taken at 9 years and show a mesial drift of the upper left first molar after the loss of deciduous molars. There is very slight imbrication of the incisors, but the teeth are upright on the alveolus. The third models were taken at 13 years. The maxillary first premolars and the mandibular left second premolar were extracted nearly 2 years previously. Despite this, a marked hollowness

Given at the meeting held on October 10, 1960.

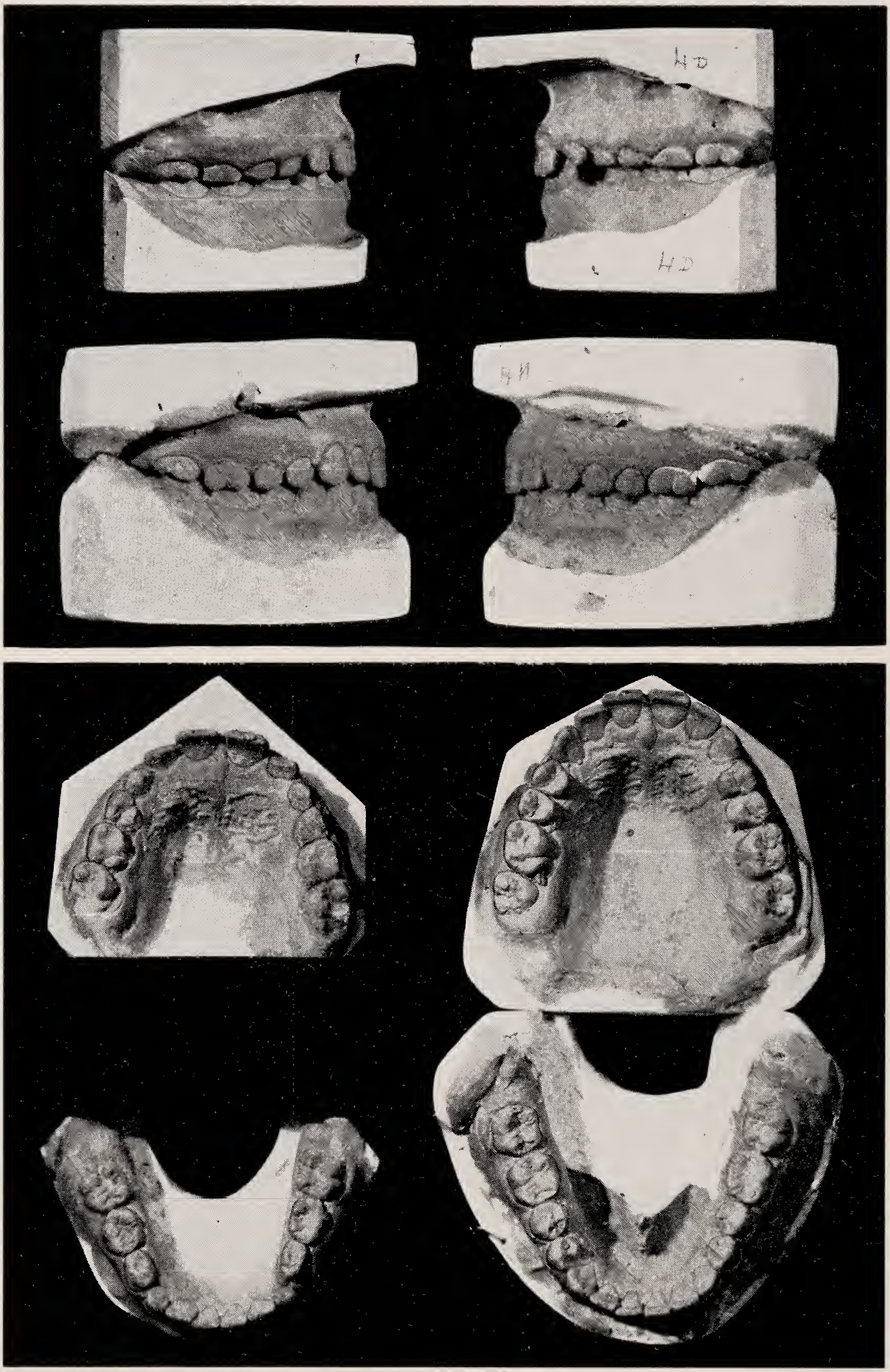

*Fig.* 1.—Models of good development at 9 and 13 years of age. Side and occlusal views.

has developed in the region of the maxillary incisor roots and the crowding of these teeth has increased considerably. The occlusal views show the increase in crowding of the teeth. In the first models there is slight spacing in the maxilla between the lateral incisors and the canines and also distal to the canines. The second models show only a slight imbrication of the maxillary incisors apart from the loss of space after premature extractions. The third models show an increased imbrication and rotation of the incisors despite the fact that the first premolars had been removed nearly 2 years previously. The intercanine breadth at the gum margin

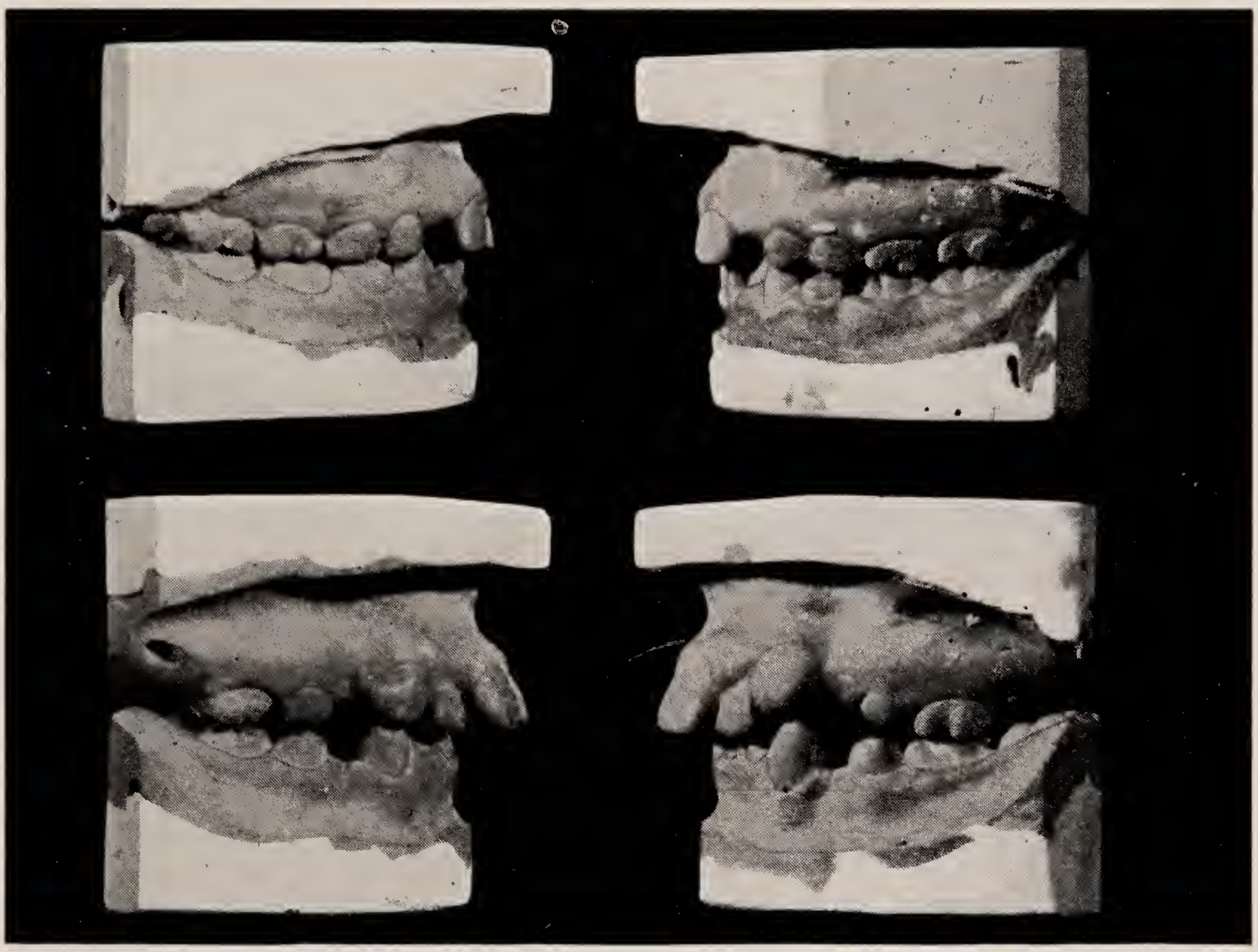

*Fig.* 2.—*Case* 1. Models at 8 years 6 months and at 11 years 4 months. Side and occlusal views.

ncreased between the first and second models by 2·8 mm., but decreased between the second and third models by 1·4 mm. The medical history was good and the only illness between 9 and 13 years was measles at 10 years. This girl, however, differed from the other two by growing very tall and at 13 years her height was 5 ft. $6\frac{3}{4}$ in.

## CONCLUSIONS

None of these children had any sucking habits or habits of tongue or lips which could account even for the alteration in the inclination of the teeth; in any case, the results of these habits, if they were to become apparent, should have done so when the incisors were erupting and not entirely later.

Nothing could be found in the literature showing similar maldevelopment at this late stage. The only explanation which can be suggested is that the downward and forward migration of the dental arch has continued,

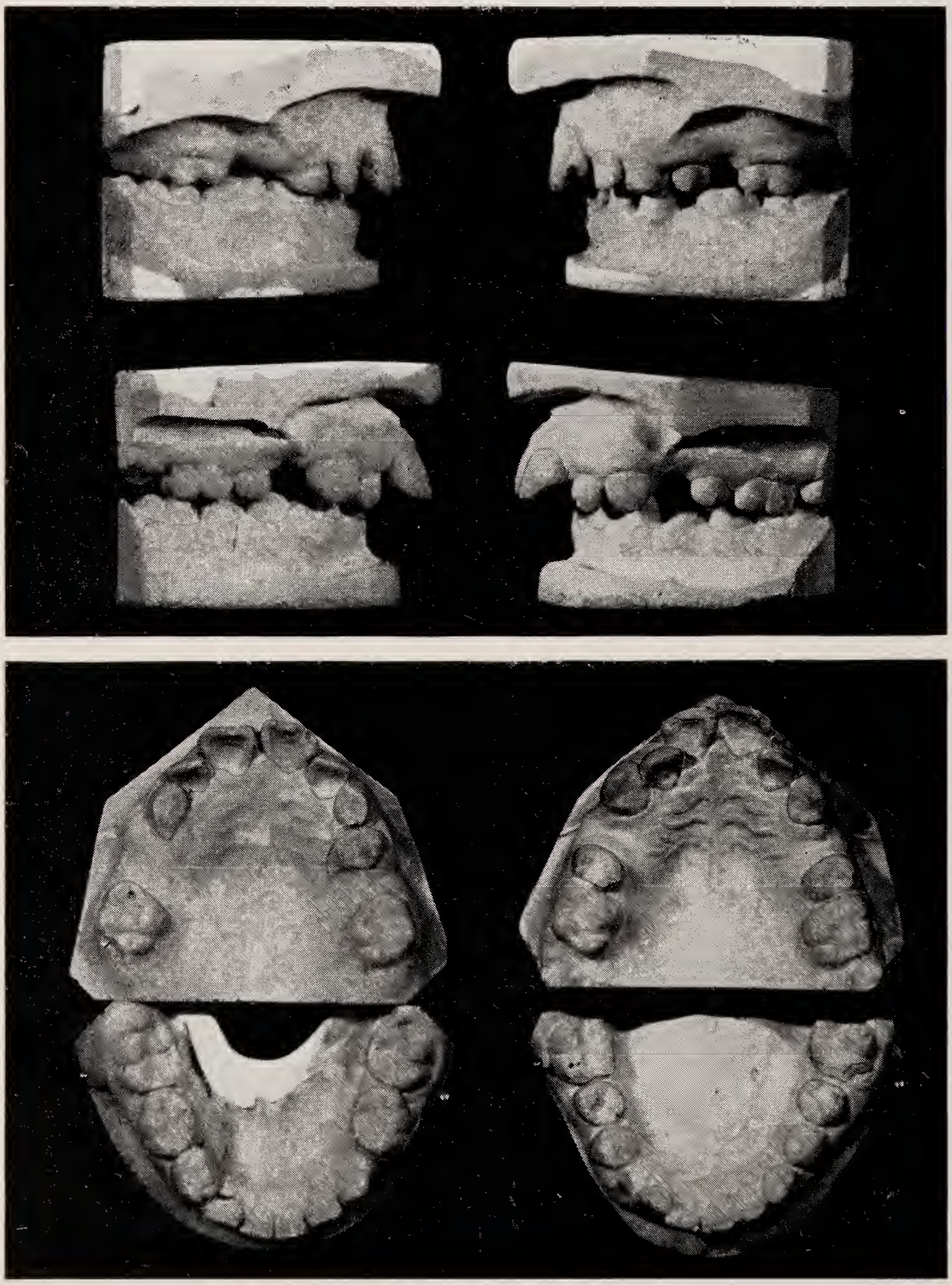

*Fig.* 3.—*Case* 2. Models at 9 years 8 months and at 12 years 4 months.

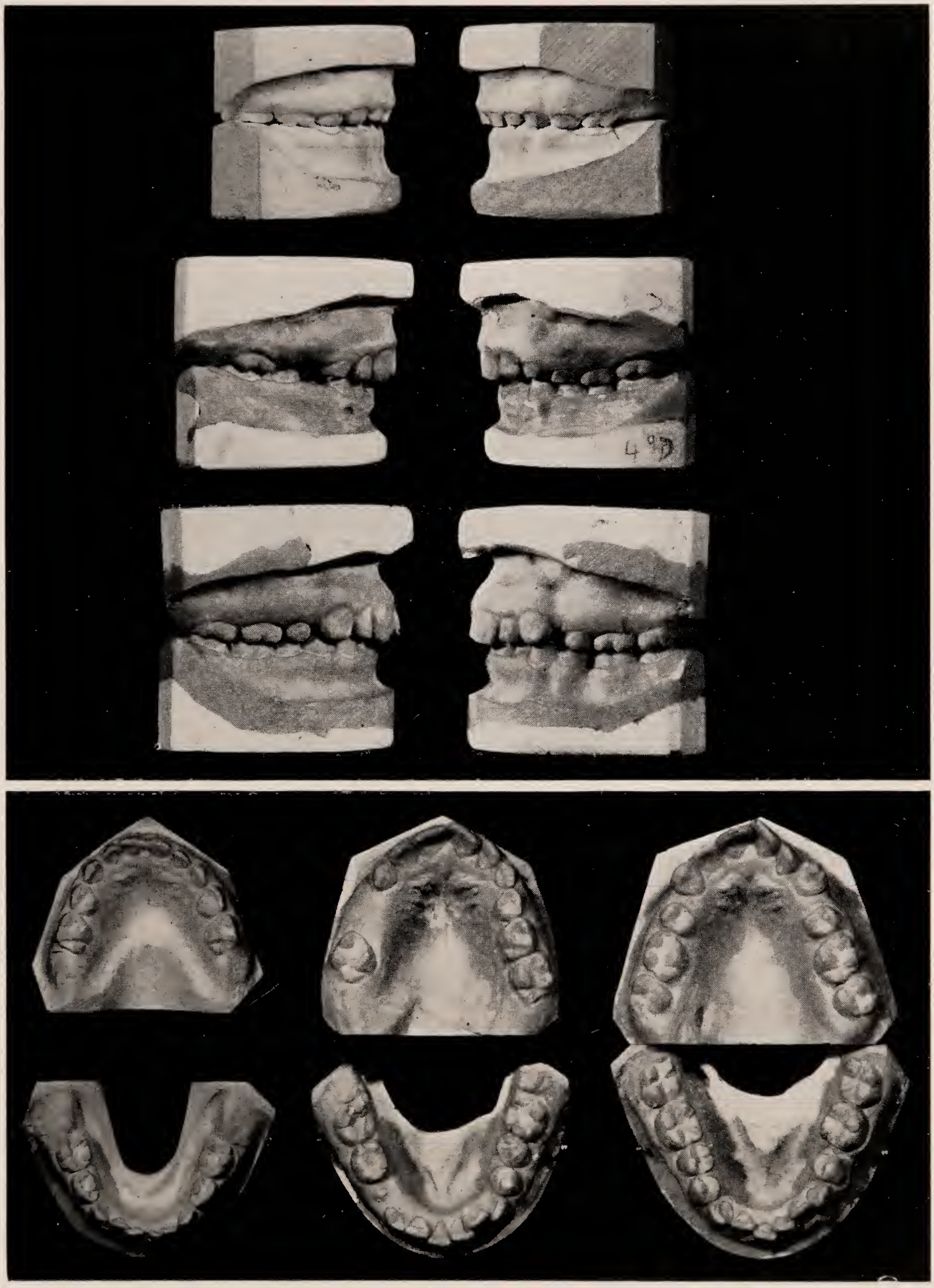

*Fig.* 4.—*Case* 3. Models at 4 years, 9 years, and 13 years. Side and occlusal views.

but that in these children there has been a relatively small amount of bone deposition in the area of the maxillary incisors particularly, and this has resulted in the first two cases in an increase in labial tilting of the teeth and in the third case in a marked increase of imbrication. Scott has stated that in the facial skeleton, after 7 years of age, growth by surface deposition and absorption of bone is predominant in the development of the face, and it is at this stage that these children showed such rapid increase in the degree of their malocclusion.


REFERENCE

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## *DISCUSSION*

*Mr. E. K. Breakspear* asked whether Miss Clinch had any record of whether any of the cases were left-handed or right-handed?

*Miss Clinch* replied that she had no record of those particular cases. She had kept information concerning right- or left-handedness for quite a long time with many of her cases, but it had not seemed relevant, so she had ceased to do it.

*Mr. D. T. Hartley* said that Miss Clinch had referred to an increase in the hollowing of the alveolar process over the maxillary incisors as the patients got older. It seemed to him that there was simply an increase in labial tilt of the incisors and that the hollowing was purely relative. Had Miss Clinch any measurements to support her observation?

*Miss Clinch* replied that she did not think the hollowness could be measured. Possibly the illustrations might show it more clearly than the slides. If Mr. Hartley had seen the models, he would have no doubt about it. With regard to the roots of the teeth, one almost felt that there was no bone on the labial aspect of the roots at all; one could get a tilting of the teeth without having that apparent lack of bone in that area. One could get tilting of the teeth round the area of the gum margin in which case the roots might actually move lingually. In these particular cases, it seemed that the incisors had to move forward with the arch but there was the minimum of bone deposition in their labial surfaces.

*Mr. W. J. Tulley* asked Miss Clinch about the shape of the lips and their position at rest and in function.

*Miss Clinch* said that the first time she had seen the children, she had made the usual note about lip position. In all of them the lips were together at rest. By the time she saw them again, it was quite obviously becoming extremely difficult for the children to keep the lips together. That applied in the first two cases, but not the third. In the third, the lips were together even when the last model was made. In the other two cases, the upper incisors were apparently resting on the lower lip, but it had seemed to her that this was due to the new position of the teeth. The lips could not accommodate them in their new position.

Another speaker asked whether the lower lip actually covered the upper part of the upper anteriors.

*Miss Clinch* replied that when she first saw the children the lower lip was above the tips of the upper incisors. That was one of the things she always made a note of. When she first saw these cases, she simply made her regular routine check of them. She had not known that anything peculiar was going to happen to them afterwards or that the malocclusions were going to get much worse.

She had the records made at that time about lip position and from them it would seem, to her at any rate, that the lips were in a perfectly favourable position. They were together at rest and there was no strain, and they were together with the lower lip up above the tips of the upper incisors.

*The President* thanked Miss Clinch for bringing the cases to their notice.

# CASES TREATED BY EXTRACTION OF PERMANENT CANINES

By **J. S. ROSE**, B.D.S., F.D.S., D.Orth. R.C.S.,
and **R. J. SHARLAND**, M.B., B.S., B.D.S., F.D.S. R.C.S.

THE problem of crowding in the upper anterior segment is most commonly solved by the extraction of two upper first premolars, and subsequent retraction of the canines followed by alinement of the incisors. However, from time to time a very satisfactory æsthetic and functional result can be obtained with the apex lying medially near to the lateral incisor.

3. Cases in which a compromise result is acceptable if treatment time is to be greatly reduced.

A series of 9 cases was shown in which canines had been extracted during orthodontic

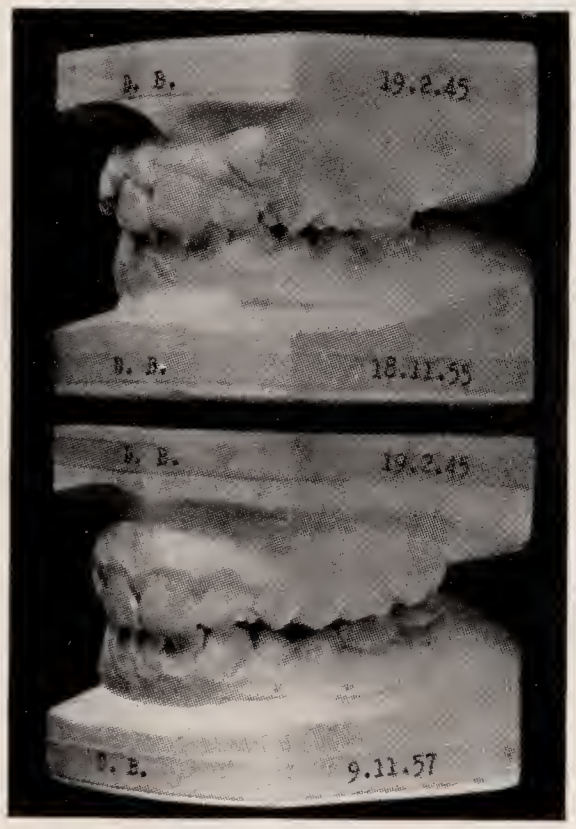


*Fig.* 1.—$\frac{5|3}{4|}$ extracted. An upper retraction plate was worn for three months.

*Fig.* 2.—$\frac{5|3}{4|4}$ were extracted. An upper retraction plate was worn for six months.

*Fig.* 3.—$\frac{3|3}{4|}$ were extracted. An upper retraction plate was worn for one year.

minimum of appliance therapy, by extraction of the upper permanent canines.

Cases in which removal of these teeth may be indicated are:—

1. Those in which the lateral incisors and first premolars are in contact, especially when the latter tooth does not show any rotation.

2. Where the canine has a markedly unfavourable axial inclination, with the treatment. The average time during which appliances were worn was 8 months. In no case was any flattening of the facial contour noticed, even where the extraction was unilateral. Three of the cases are illustrated here.

**Acknowledgement.**—We should like to express our appreciation to Mr. R. F. C. Thomas for the preparation of the models.

A demonstration given at the meeting held on May 9, 1960.

# A DAYLIGHT TRACING BOX

By **G. H. STEEL,** B.D.S. (Dunelm.), F.D.S., D.Orth. R.C.S.
*Senior Registrar in Orthodontics, Newcastle upon Tyne Dental Hospital*

It is difficult to identify the cephalometric landmarks on lateral skull radiographs when viewed in normal daylight. When tracing paper is superimposed and tracing attempted it is almost impossible. This box was developed to facilitate the tracing of lateral skull radiographs without resorting to a dark-room.

*Fig.* 1.—Tracing box in use.

Essentially, this tracing box (*Fig.* 1) consists of a cylinder having the lower end open with apertures in the top and side. The top aperture permits viewing, and is fitted with a face-piece taken from a rubber diving mask. The side aperture allows access of the hand to the interior of the box when tracing. It is fitted with a light-proof cuff, the 3-in. wrist portion of a black rubber glove serving this purpose. The lower border of the cylinder is covered by split rubber tubing, to avoid damage to the radiograph. Finally, the interior has a matt black finish to eliminate internal reflection.

This box, when used in conjunction with a horizontal viewing box under normal room light conditions, enables one to identify easily the cephalometric landmarks, even when tracing paper is superimposed (*Fig.* 2). By excluding room light there is no reflection from the surface of the film, the radiograph being illuminated solely by transmitted light. The box also exerts a masking effect, thus intensifying one's view of the pertinent area. These two effects increase the apparent contrast of the radiograph and thereby clarify the cephalometric landmarks and soft tissue outlines.

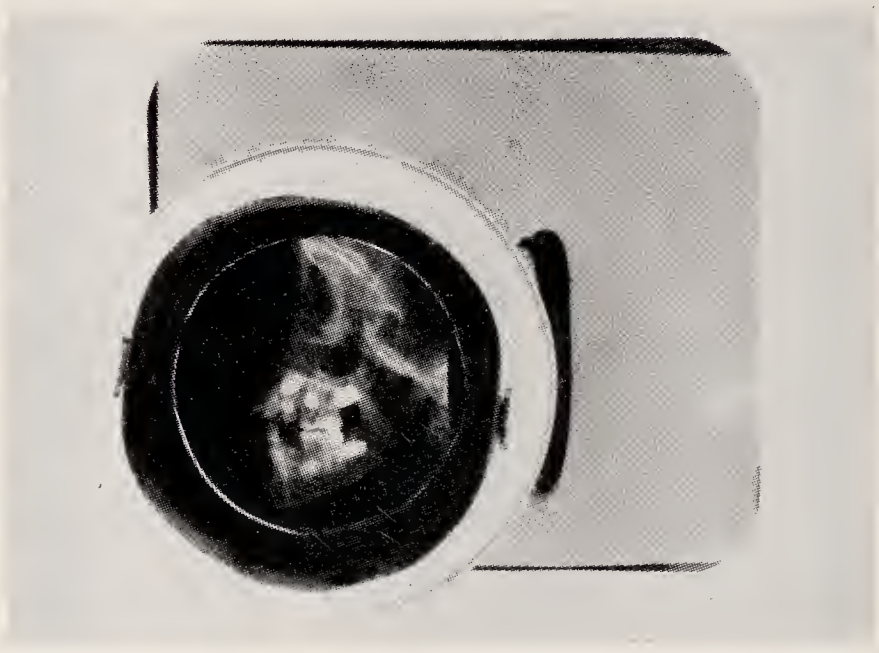

*Fig.* 2.—Note contrast between areas of radiograph inside and outside of tracing box.

**Acknowledgements.**—I am grateful to the Photographic Department for the photographs and to Mr. J. Roxby, Senior Dental Technician, Newcastle upon Tyne Dental Hospital, for his help in the construction of this tracing box.

A demonstration at the meeting held on May 9, 1960.

# VARIOUS TYPES OF EXTRA-ORAL ANCHORAGE APPLIANCES

By **R. MARX**, B.D.S., L.D.S., D.Orth. R.C.S.
*Royal Dental Hospital of London*

EXTRA-ORAL anchorage is nothing new to orthodontics. It was used as far back as 1822, and was described by Kneisel (1836), Gunnell (1842), C. Tomes (1873), Angle (1889), and others.

Extra-oral apparatus may be used to reinforce intra-oral anchorage, or as the sole means by which force is exerted to stimulate tooth movement.

The appliances shown were a selection of those that have been used in the past and some, including those illustrated photographically, are being used at present in the Orthodontic Department of the Royal Dental Hospital, London, and are described here.

They may be placed into three main groups: (1) Cervical; (2) Occipital; (3) Cervico-mental.

**1. Cervical.**—The apparatus being used at present consists of polyvinyl chloride non-toxic tubing (bore 7 mm., exterior diameter 11 mm., Shore hardness 82), inside which an elastic band connects two lengths of 1-mm. wire. The protruding ends of the wire are bent into hooks, which engage the labial bow of a removable or fixed intra-oral appliance (*Figs.* 1–4).

This apparatus may also be used in combination with a removable "cat's whisker" bow (*Fig.* 5). This gear is well tolerated by patients, and is easy to make. The disadvantage in its use is that the force exerted has a downward component which may be undesirable.

**2. Occipital.**—Two forms of headgear are in use at the moment:—

*a.* Plastic tape, 2 cm. wide, is used to construct the cap (*Fig.* 6) as described by McCallin (1954). A sagittal strap, not shown in the photograph, connects the coronal and horizontal straps. A hook on each side provides the attachment for elastic bands which are connected to a "cat's whisker" bow. The

*Fig.* 1.—Cervical gear showing component parts.

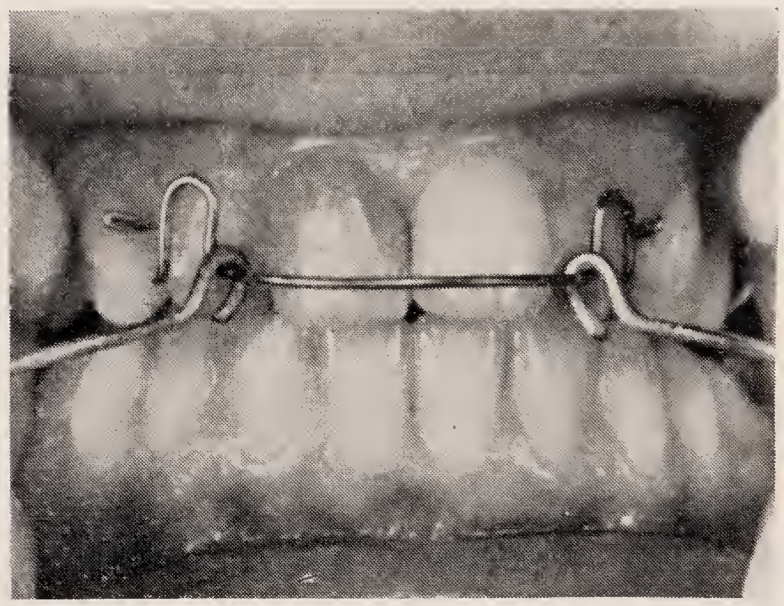

*Fig.* 2.—Method of attaching cervical gear directly to labial bow of removable appliance.

*Fig.* 3.—Method of attaching cervical gear directly to multiband fixed appliance.

A demonstration given at the meeting held on May 9, 1960.

advantage of this apparatus is its simplicity. It is comfortable to wear, does not shrink on washing, and requires no sewing or stapling. The hooks may be positioned so as to provide

*Fig.* 4.—Patient wearing cervical gear.

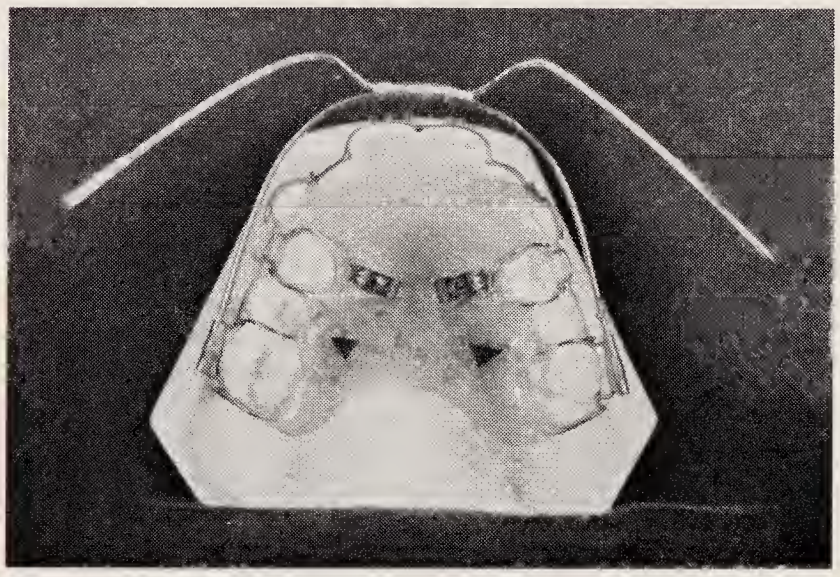

*Fig.* 5.—Removable appliance with "cat's whisker" bow slightly withdrawn from tubes on molar cribs to show stops. Extra-oral apparatus is here being used to reinforce anchorage.

traction in an upward and backward direction. This material, although not specifically non-toxic, has not produced any allergic skin reactions during years of use in this hospital.

*b.* Plastic tape is used in conjunction with polyvinyl chloride tubing, as described above. Traction can thus be directed along the occlusal plane or higher. This gear obviates the need for a "cat's whisker" bow (*Fig.* 7).

**3. Cervico-mental.**—This apparatus consists of an acrylic chin cap made as described by Burnapp and Kettle (1955), used in conjunction with the cervical gear described

*Fig.* 6.—Plastic tape occipital head gear with "cat's whisker" bow.

above. Traction is applied to the chin cap by connecting the cervical gear to hooks embedded in the acrylic. Elastic bands pass from acrylic posts into the mouth, being

*Fig.* 7.—Head gear made of plastic tape and polyvinyl chloride tubing.

be used, as advocated by Oppenheim in a personal communication to Jerrold (1945), to act on the maxillary arch only, the force being so balanced as to avoid pressure against the lower labial segment. In the case illustrated (*Figs.* 8, 9) the apparatus is being used to move the maxillary buccal segments mesially.

*Fig.* 8.—To show elastic band passing back into the mouth from a post on the acrylic chin cap.

*Fig.* 9.—Cervico-mental apparatus on the patient.

attached to a removable or fixed maxillary appliance. The force exerted may be balanced so that pressure is applied by the chin cap against the lower labial segment via the lower lip, thus retroclining the lower incisors, while at the same time the maxillary arch is pulled forward. Alternatively, the apparatus may

**Acknowledgements.**—I wish to thank Mr. D. P. Walther, Director of the Orthodontic Department, Royal Dental Hospital, for his encouragement and advice; Mr. O. Krogstad, Sandfjord, Norway, for introducing me to the use of plastic tubing in orthodontics; and Mr. R. P. Palmer, Imperial Chemical

Industries, Plastics Division, for generously producing a sample of polyvinyl chloride non-toxic tubing. I am also indebted to members of the staff of the orthodontic laboratory and photographic department, Royal Dental Hospital, for their assistance in the preparation of exhibits, and to the Librarian, Royal Dental Hospital.

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# FURTHER OBSERVATIONS ON EARLY LOSS OF DECIDUOUS MOLARS

By **E. K. BREAKSPEAR**, L.D.S., D.Orth. R.C.S.(Eng.)
*Part-time Orthodontist, City of Birmingham*

PASSIONS tend to cool with time; and if this subject no longer arouses the same fierce arguments as of old, it is because we have learned that truth is to be found on both sides. Premature loss of deciduous molars is not so profound a cause of malocclusion as was formerly thought (Lundström, 1955); nevertheless it presents a continuing problem to all who have to do with children's dentistry, and its effects cannot be ignored.

With the growth of interest in fundamental orthodontics in the last decade, the effect of adventitious factors such as early extractions has become a relatively neglected field. I believe, however, that quite apart from any clinical applications there is a treasure-house of knowledge waiting to be unearthed here, capable of throwing light on many wider problems.

There are eight deciduous molars in each normal mouth, and one cause of confusion in the past has, I feel, been insufficient separation of the differing effects of extracting one of the eight rather than another. In my previous paper on this subject (Breakspear, 1951) I tried to clarify the position, concentrating mainly on single extractions. Perhaps the most important finding at that time was the high rate of space loss for the second deciduous molar compared with the first, especially in the upper arch. There was also in my material a number of cases of double extractions, too small for detailed analysis, but enough to show some rather surprising tendencies.

The purpose of this paper is to examine these tendencies in a larger material, and to discuss possible causes. I therefore propose to confine myself to the differences between double and single extractions and the points arising, leaving other matters to another occasion. In this context, I mean by "double extractions" the simultaneous extraction of two adjacent deciduous teeth, i.e., D and E together. The principal studies on this subject in general since 1951 have been those of Lundström (1955), Clinch (1958a), Linder-Aronson (1958), and recently Halikis (1960). Much valuable information is contained in these reports, but none of them refers directly to the problem of double extractions, which I believe raises new issues. The way therefore seems to be clear for a fresh approach.

## METHOD OF INVESTIGATION

The method preferred was that used in the previous study, namely a cross-sectional survey carried out before the premolars had erupted. We know that some of the space lost may be regained when the premolars erupt (Seipel, 1948), and other rectifying adjustments may occur; but I regard these as complicating factors. The best time to study the mechanism of space loss is when it is actually taking place. Even if partial recovery occurs later, it is, I think, reasonable to assume that the greatest permanent damage is likely to be seen in those cases where the space loss is greatest at an intermediate stage; though this has not yet been proved.

The method, however, presents a number of difficulties. The first is the extreme variability of the effects under study (*Fig.* 1). In Case 465, four years after extraction of $\underline{|E}$, the space has completely closed. At the other end of the scale, Case 404 (*Fig.* 2) shows a negative space loss nearly three years after extraction of $\overline{|DE}$. This is the kind of anomaly which aroused my curiosity and led to the present research. So wide a range does not make statistical work impossible, but it increases the difficulty of obtaining significant results, and in some instances one has to exercise clinical judgement and objective reasoning without precise mathematical support.

Given at the meeting held on October 10, 1960.

The second problem is that of adequate controls. So far as each individual case was concerned, I compared the remaining space, in unilateral extraction cases, with the mesio-distal length of the corresponding tooth or comparable groups of approximately equal number, two of which contained cases of unilateral extraction of two adjacent deciduous molars, in the upper and lower arches respectively; the other two consisting of cases with

*Fig.* 1.—Case showing complete space closure, in upper arch.

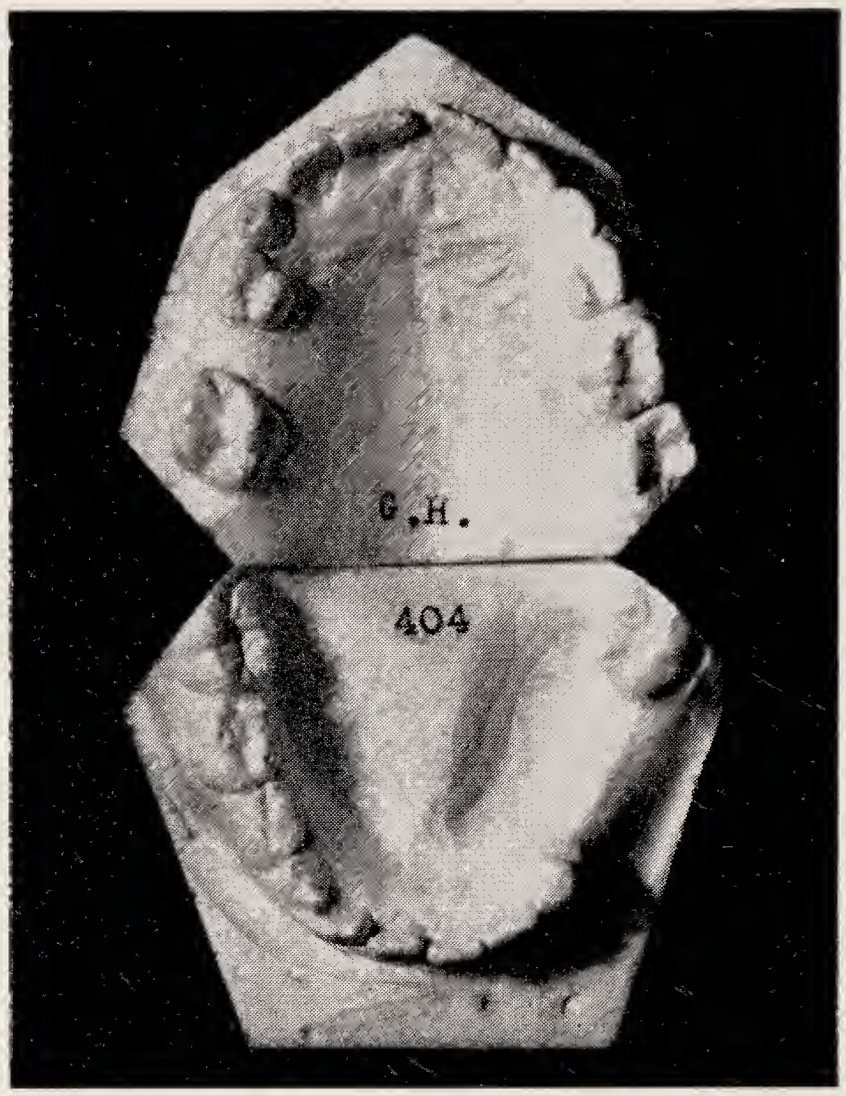



*Fig.* 2.—Case showing no space loss, in lower arch.

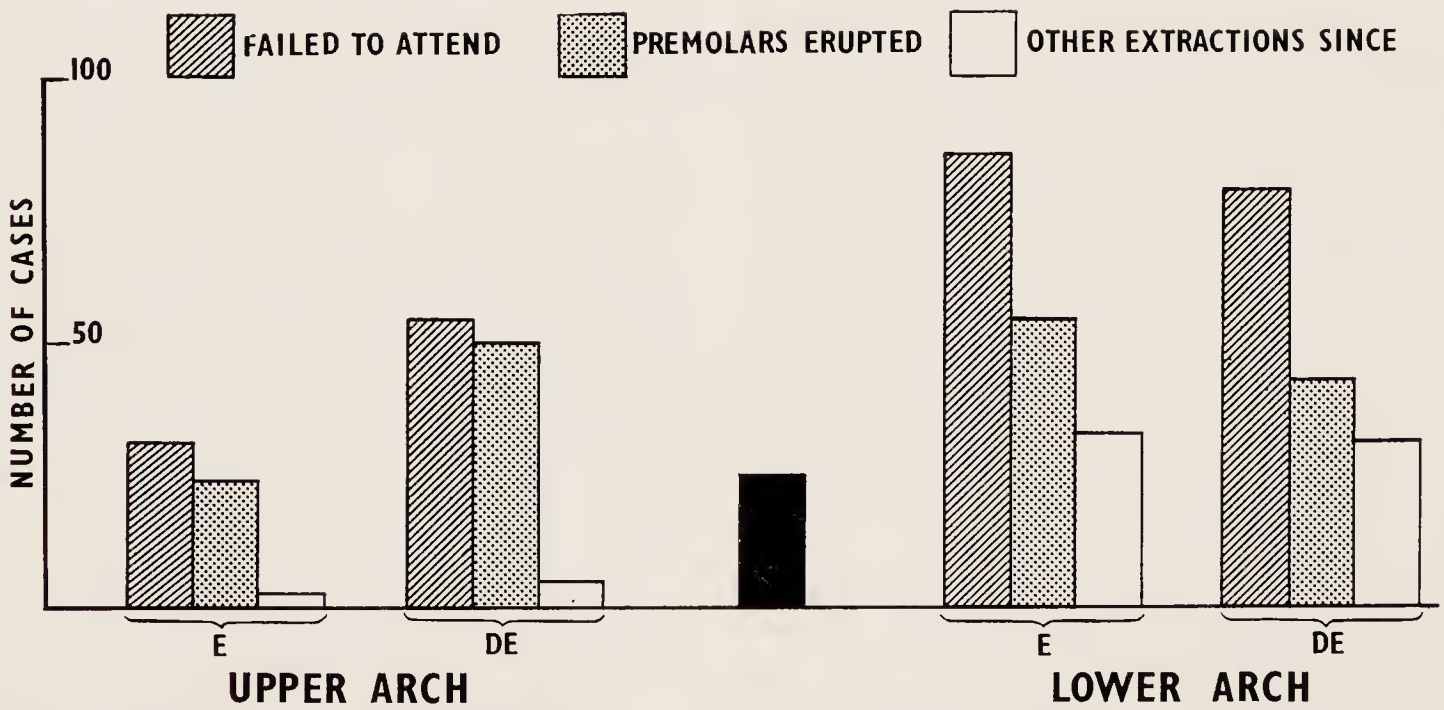



*Fig.* 3.—Prineipal causes of "wastage". The black column represents the number of cases suitable for measurement in each group (25 approx.).

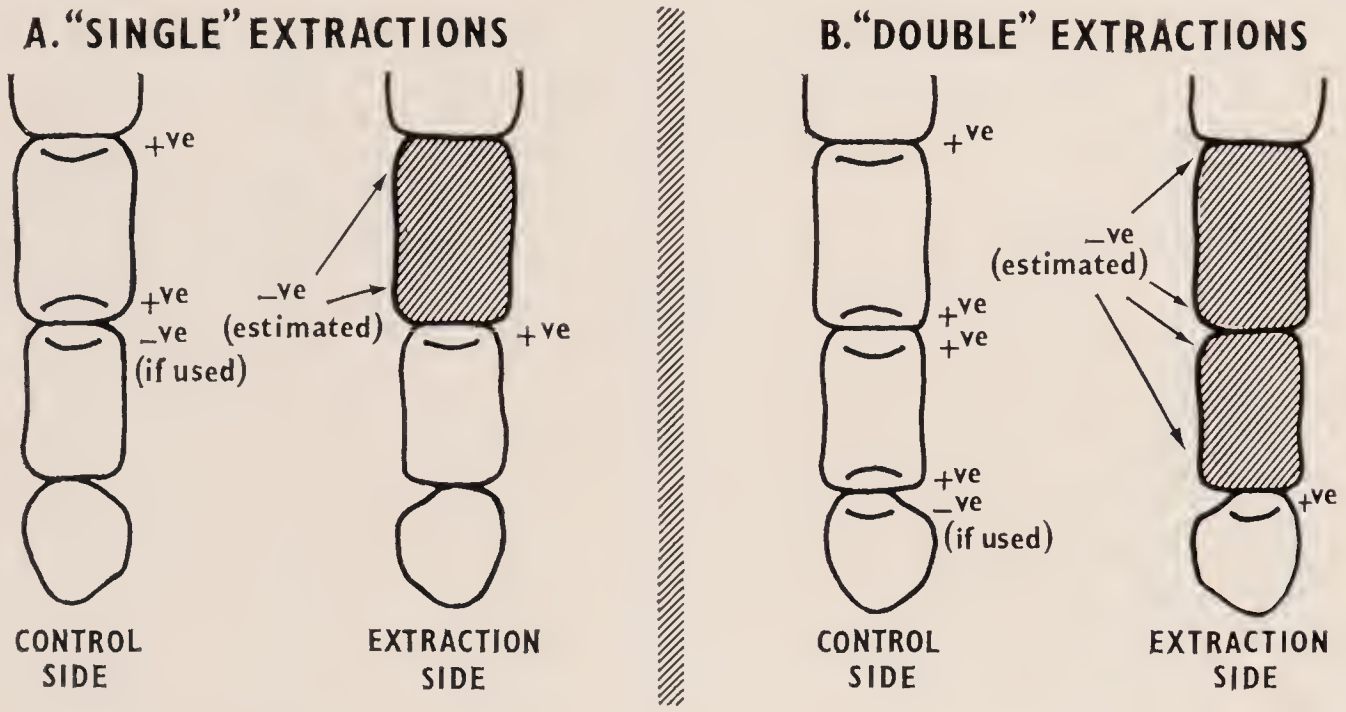
teeth on the opposite side. Lundström (1948) has shown the small amount of variability in tooth size between left and right sides of the same individual. The aim was to find four unilateral loss of one second deciduous molar only, under analogous conditions. By comparing the latter results with those for a similar group in the 1951 study, an indication

could be obtained of the reliability of the method.

The third difficulty is that of wastage (*Fig.* 3). In addition to those showing loss of control teeth, the following types of case were excluded: those with any premolar erupted in the quadrant under observation; those whose first permanent molar was not present behind the gap; and those with other extractions in the quadrant under observation.

The treatment records of the Coventry School Clinic were searched for eligible cases, who were then asked to attend for examination. It was originally intended to find 4 groups of 50, making 200 in all. It soon became clear, however, that this would not be possible, and the "target" was reduced to 4 groups of 25, making up 100. The actual number measured was 102.

In order to achieve this, the number asked to attend was 618. The reasons for the very high wastage are shown to be: first, failure to attend; second, eruption of premolars; third, other relevant extractions since the last recorded visit to the Clinic. Comparing the 4 groups, it can be seen that the lower "single" and lower "double" groups were reasonably comparable. The 2 upper groups were of a similar pattern as between themselves, differing from the lower groups in earlier eruption of premolars (Gardiner, 1955), and fewer losses by caries (Halikis, 1960). The total wastage was considerably less in the upper E group than the others; though the possible effect of this on the results in general is not immediately clear.




(+ve or −ve corrections to be applied to apparent space loss as indicated)

*Fig.* 4.—Corrections due to interstitial caries.

*Table I.*—Comparability of Groups

| | | *Group* | *Mean* Yr. | Mth. |
|---|---|---|---|---|
| 1. *Age at time of extraction* | (Overall mean: 6 yr. 7 mth.) | Upper E | 6 | 4 |
| | | Upper DE | 6 | 9 |
| | | Lower E | 6 | 7 |
| | | Lower DE | 6 | 9 |
| 2. *Interval since extraction* | (Overall mean: 1 yr. 10 mth.) | Upper E | 2 | 3 |
| | | Upper DE | 1 | 5 |
| | | Lower E | 1 | 10 |
| | | Lower DE | 1 | 10 |
| 3. *Age at time of examination* | (Overall mean: 8 yr. 5 mth.) | Upper E | 8 | 7 |
| | | Upper DE | 8 | 2 |
| | | Lower E | 8 | 5 |
| | | Lower DE | 8 | 7 |

Considering now the internal comparability of the 4 groups, *Table I* shows, I hope, a reasonable similarity so far as time factors are

concerned. The chief difference is in the average interval between extraction and measurement, which was higher than average in the upper E group, and rather lower in the upper DE group: this will be discussed later. The 2 "lower" groups were again comparable. The overall *ranges* were as follows: age at time of extraction, 3 years 9 months to 9 years 10 months; interval since extraction, 4 months to 4½ years; age at examination, 6 to 11 years.

About twenty observations were made on each case measured, but only the following concern us here: mesiodistal dimensions of extraction spaces and control teeth measured clinically to the nearest half-millimetre; encroachment of contact points by caries, judged anatomically to the nearest half-millimetre; tongue behaviour; cuspal lock; and right- or left- handedness in writing. Models were made in cases of particular interest, but not as a routine.

The largest source of error in this type of study is probably the encroachment of the extracted teeth by caries, which can only be estimated. Fortunately there is some basis for doing this, as explained in the 1951 paper, and the graph constructed then was used on this occasion. It will not always be correct for an individual case, but will be somewhere near the mark for a group of cases. The corrections applied are shown in *Fig.* 4. In general, encroachment of the control teeth would make the space loss seem too low, and call for a positive correction; while encroachment of the extracted teeth, by interstitial caries, would make the loss of space due to the *extraction* appear too high, requiring a negative correction.

It was not easy to decide what figure to use for prior encroachment in cases of double extractions, but I eventually settled on the arbitrary one of 1·6 times the allowance for a second deciduous molar alone. This, I think, is a fairly realistic figure, and I have used the same proportion to formulate the theoretical value "V", which will appear later.

After making these corrections, the figures were converted into the standard form of "Mean Rate of Space Loss", in millimetres per year, which was the basis of comparison. The overall mean was 1·75 mm. per year, but the individual cases ranged from plus 5·5 to minus 2·8 mm. per year; these values are, however, to some extent artificial. The actual loss observed would depend on the length of time during which the space loss had been proceeding, and prognosis would likewise depend on the period likely to elapse before the premolars might erupt.

The question of the linearity of tooth movements will rightly be raised at this point. So far as I could judge by my 1951 results, the rate of space loss appeared to be fairly steady in general, but with a tendency for space to be lost a little more rapidly at first, and somewhat less rapidly as the premolars prepared to erupt. By comparing groups with a comparable range of time intervals, these differences would tend to be evened out; in the case of the two upper groups, however, any error due to this cause would be in the direction of artificially lowering the upper E rate and artificially raising the upper DE rate.

In this investigation the basis of comparison is not the individual but the group. Many possible sources of error are reduced by this means, even in the small numbers available. In spite of the variability, it was found that sub-groups of as few as 10 or 12 cases did, in fact, offer reasonable possibilities for comparisons to be usefully made.

Dockrell (1960) confirms the levelling effect of group analysis in connexion with possible individual growth spurts, over an age range which covers that of our present subjects, with very few exceptions.

## RESULTS OBTAINED

Let us now consider what we might expect to see (*Fig.* 5). If any break in the dental arch were of equal importance, each of the columns representing mean rate of space loss would be of the same height, as in (*a*). If, however, the rate of space loss were proportional to the amount of tooth substance lost, the relation of the D, E, and DE groups would be as in (*b*), where the third column is the sum of the previous two.

What we actually see is a modified version of this, as in (*c*). The third column is not the

sum of the first two, but is slightly less than the second: in other words, the effect of removing D and E together appears to be no worse, and if anything slightly better, than that of

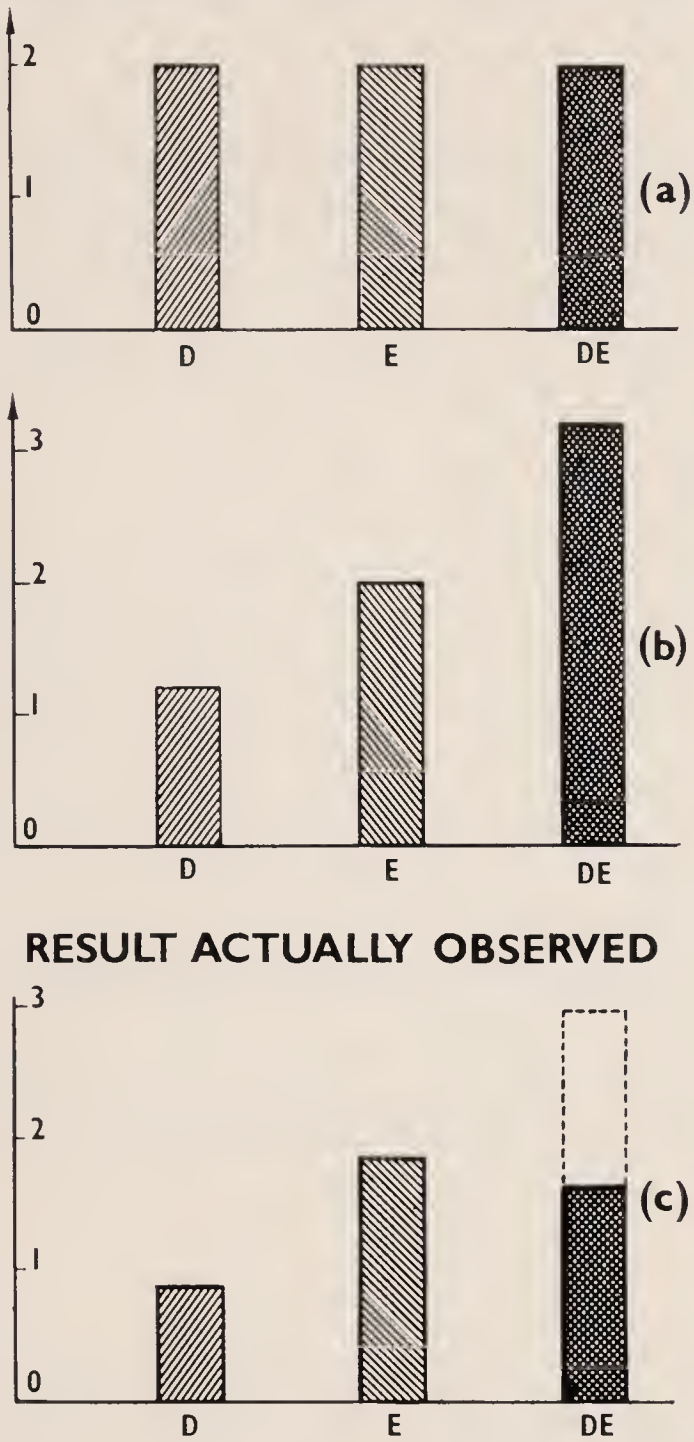



*Fig.* 5.—Possible types of result, and actual results. Mean rate of space loss in mm. per year.

removing only the E. This was the effect I had noticed in 1951, and the figures must now be considered in more detail (*Fig.* 6).

The basic similarity in the pattern for upper and lower arches can be seen. The theoretical value "V" has been put at 1·6 times the observed result for the E column, and in each case the actual result in double extraction cases is significantly below it. The difference between the E and DE columns is negligible in the upper arch as it stands, and in the lower arch does not reach the level of significance. It can, however, be said that there is no evidence that the effect of double extractions is any worse, on the average, than that of removing the second deciduous molar alone. For those who wish to examine the actual figures more closely, I have added a short statistical appendix.

Some further points should be noted. I have included the findings of the 1951 study, which related to single D and E extractions only.

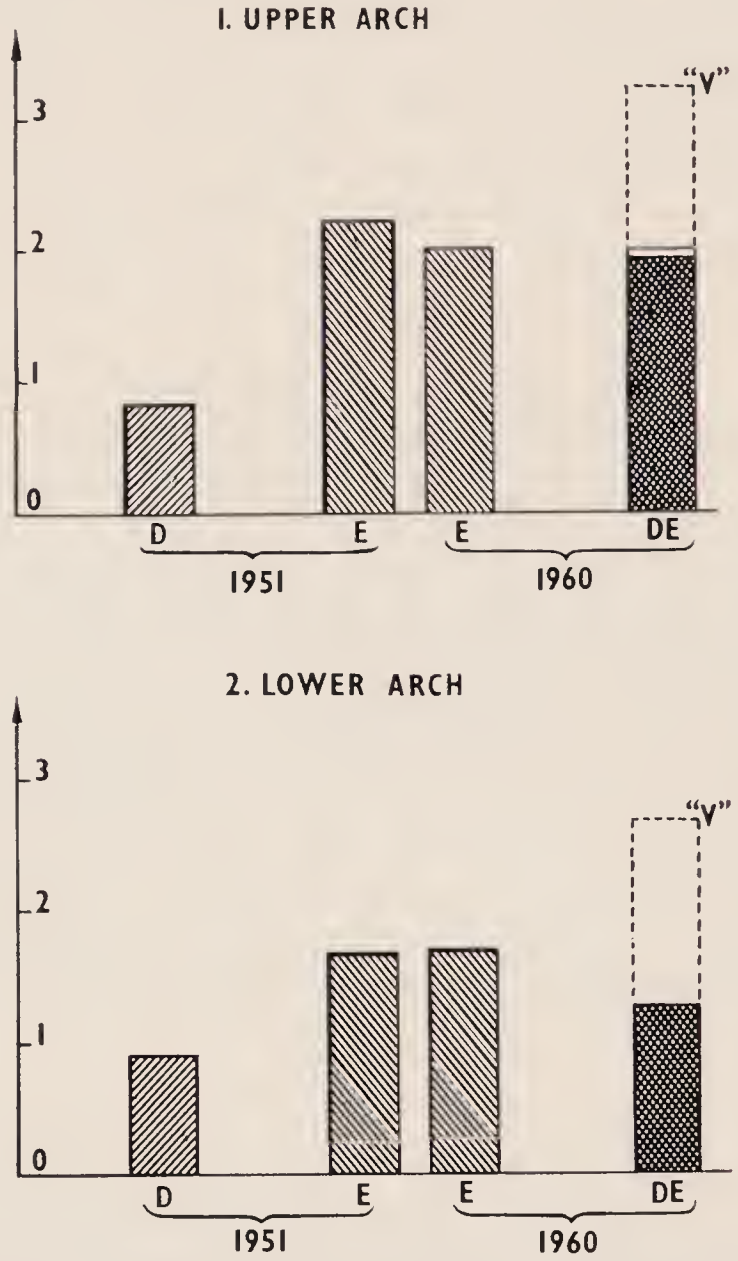



*Fig.* 6.—Actual result broken down. Mean rate of space loss in mm. per year.

The correspondence of the duplicated E columns in the two arches is a measure of the reliability of the method. In the lower arch the correspondence is very close, and in the upper arch fairly close; there is, however, reason to believe that the old upper E column is a little too high, owing to the use of a less precise method of calculating prior encroachment in 1951. The upper DE column should be slightly reduced, as shown by the bar, on account of a variation in the left–right composition of the sample; and an analysis of the influence of the different time interval between

extraction and measurement in the 2 upper groups, mentioned earlier, would probably tend to depress the upper DE column still further, thus producing a relationship more nearly resembling that in the lower arch. It is therefore felt that the general approach is justified, and that in spite of small numbers, useful comparisons can be made.

It should also be noted that the lowest rate of space loss is still that for the *first* deciduous molar. Although the double extraction columns tend to be slightly lower than the E columns, they are nevertheless higher than the D columns. This emphasizes the importance of preserving the second deciduous molar whenever possible.

## POSSIBLE EXPLANATIONS

If my interpretation is correct, there seems to be some "checking factor" at work (perhaps more than one) tending to reduce the space loss in cases of double extractions. I believe the most important of these to be the action of the tongue, which can more easily enter a larger space than a smaller; the cheek muscles may also play a part. Another factor which operates in some cases is the cuspal lock: slight over-eruption of the opposing teeth may be more likely when 2 teeth are missing than when only 1 is lost.

These factors would influence both upper and lower arches; some might have a relatively favourable effect on the lower arch especially. One is the Curve of Spee, which may facilitate cuspal lock in the lower arch; another is the fact that more lower deciduous molars are lost than uppers (Halikis, 1960). The importance of this is that, when the extraction space is beyond a certain size, tongue pressure may become less effective through diffusion; this would happen more often in relation to primary upper extractions than vice versa. A further point is the anatomical proximity of the tongue to the lower arch; any or all of these might be responsible for the apparently greater checking effect in the lower arch. The efficiency of the checking action might also be affected by, for example, the type of swallowing.

An attempt was made to confirm these theories statistically and clinically. From the statistical point of view, the material presented difficulties due to small sub-groups and high variability. Nevertheless it was possible here and there to find sufficiently comparable elements. The first of these is set out in *Table II A*.

*Table II.*—Significance of Observations

*A*

1. *Significant results* (difference more than 2 times Standard Error):
   - *a.* Good cuspal lock more frequent in "lower" groups than upper.
   - *b.* Tongue bulge more frequent in "double" groups than single.
     (*Deduction*: Low rate of space loss in "lower double" group may be attributable to these factors if they are favourable.)
   - *c.* Diversion of tongue bulge more frequently associated with primary upper extractions than with lower.
     (*Deduction*: This may also assist *lower* groups, if favourable.)
2. *Sub-significant result* (difference between 1·5 and 2 times Standard Error):
   - *d.* In lower E group, cases with tongue bulge showed less rapid space loss than cases without tongue bulge.
     (*Deduction*: Tongue bulge appears to be advantageous.)

*B*

3. *Non-significant but possibly relevant results* (difference below 1·5 times Standard Error):
   - *e.* In lower DE group, cases with good cuspal lock showed less rapid space loss than cases with poor cuspal lock.
     (*Provisional deduction*: Good cuspal lock appears advantageous.)
   - *f.* In upper DE group, cases with diverted tongue bulge showed more rapid space loss than cases with non-diverted bulge.
     (*Provisional deduction*: Diversion of tongue bulge appears to be disadvantageous to the arch of primary extraction.)
   - *g.* In lower DE group cases with tongue bulge, cases with teeth-together swallow showed less rapid space loss than cases with teeth-apart swallow.
     (*Provisional deduction*: Bulge mechanism appears to act more efficiently in presence of teeth-together swallow.)

Since actual figures for such small samples might be misleading, I have deemed it best to express them qualitatively, though fuller details are given in the Appendix. I have also grouped them in order of significance. For the benefit of those unfamiliar with statistical procedure, I will explain that the Standard Error is a measure of the possible influence of chance in a sample of a given size and variability; a difference of twice the Standard Error represents a finding that would

occur by chance only once in 20 times, and is accepted by convention as significant. Significance is only a relative term, however, and we are entitled to accept a greater or lesser level for a particular purpose if we wish to do so.

In order to make progress in this peculiarly difficult field, I suggest that, whilst welcoming take note of findings which are not significant, since these may be real differences, though not found in sufficient numbers to be fully provable (Bradford Hill, 1959). Some of these are shown in *Table II B.*

It will be evident that the results susceptible to analysis did in fact fit into the pattern expected; if the pattern emerges more clearly in some respects than in others, it is for each of us to decide at what point to reserve judgement.

It is interesting to record in passing that results in the upper arch sometimes appeared anomalous. Apart from errors due to sampling technique, this may reinforce Clinch's observation (1958a) that more light is needed on the different response in upper and lower arches.

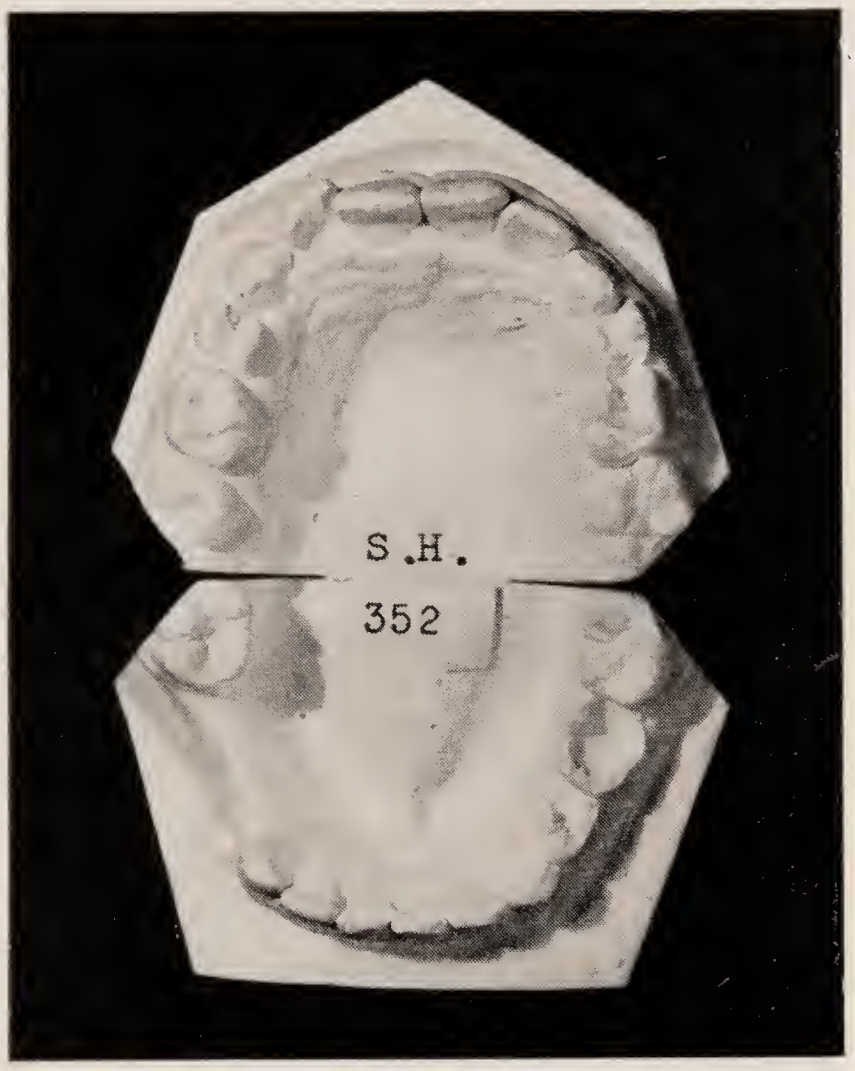



*Fig.* 7.—Case showing good space maintenance, without good natural spacing.

*Fig.* 8.—Diversion of tongue bulge by additional extractions.

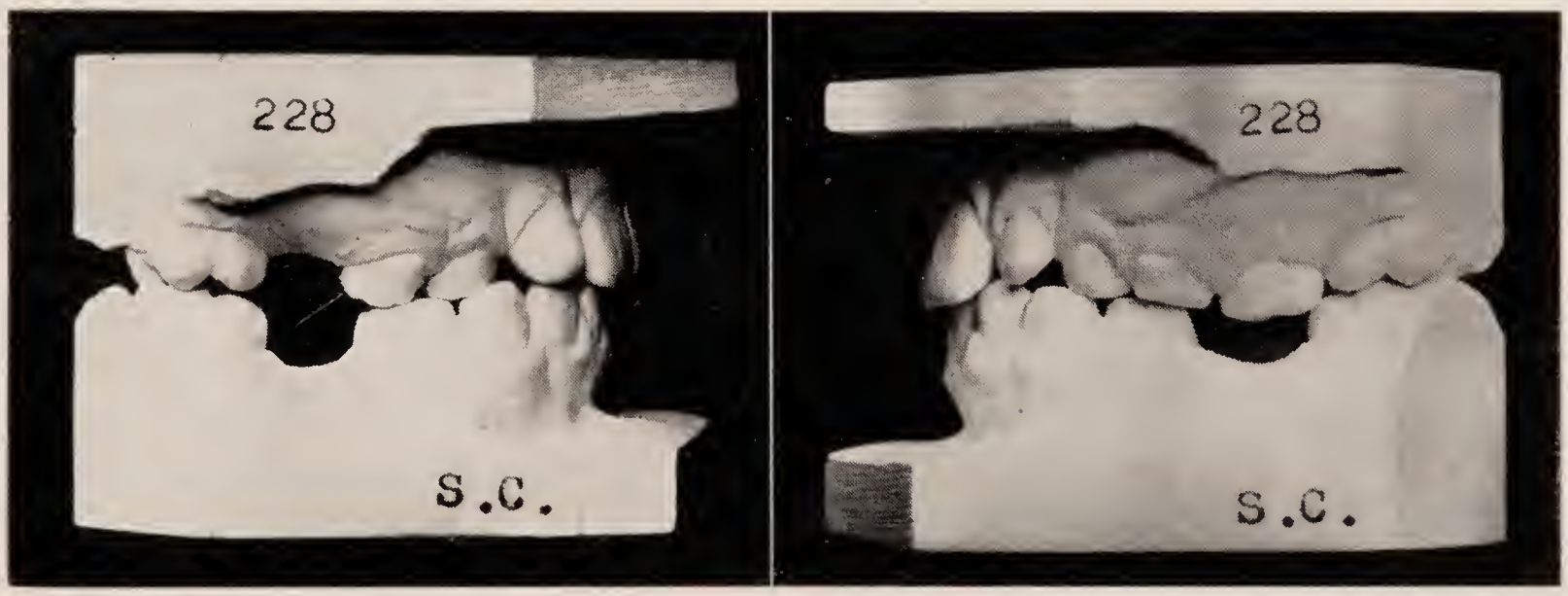



*Fig.* 9.—Left and right sides of same case compared: diversionary effect suspected on right side.

full statistical significance when it can be obtained, we should cautiously accept a level of 1·5 times the Standard Error, pending further evidence. We may also quite properly

## CLINICAL CASES

Some clinical cases will now be shown, which illustrate these points. Space maintenance *without* good natural spacing is seen in

*Fig.* 10.

*Fig.* 11.

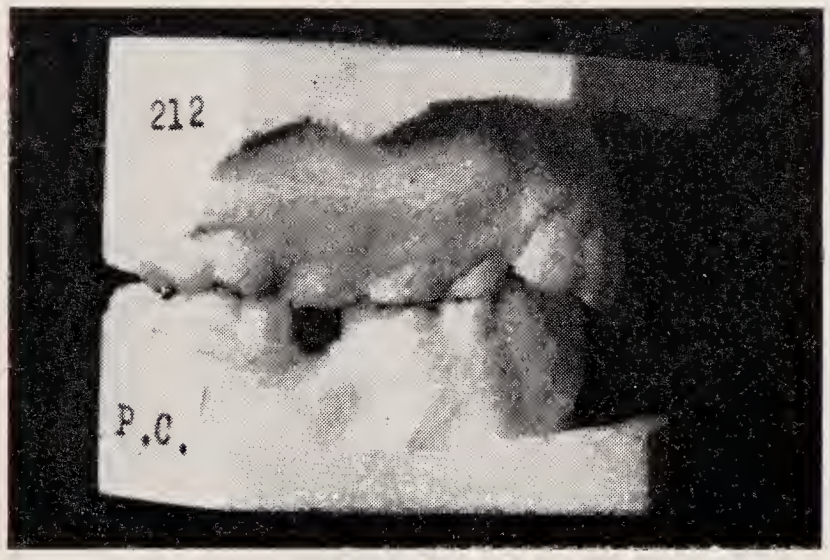



*Fig.* 12.

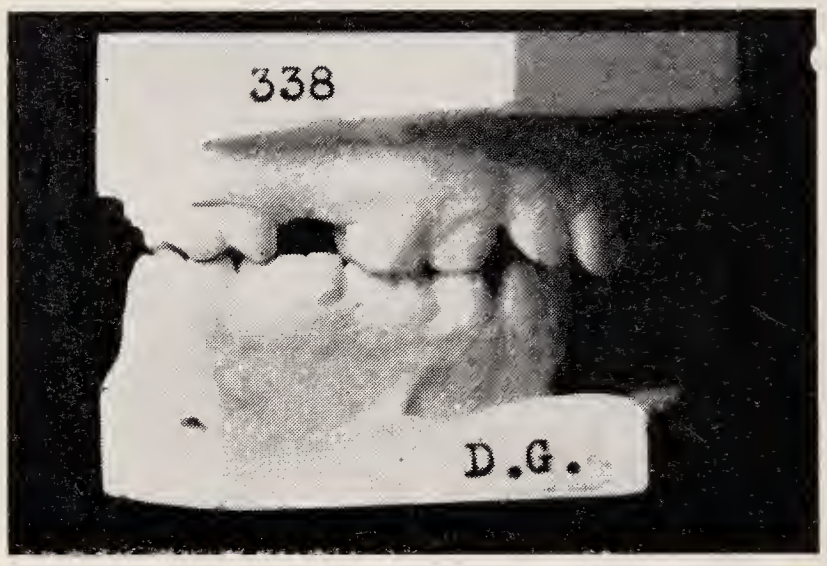



*Fig.* 13.

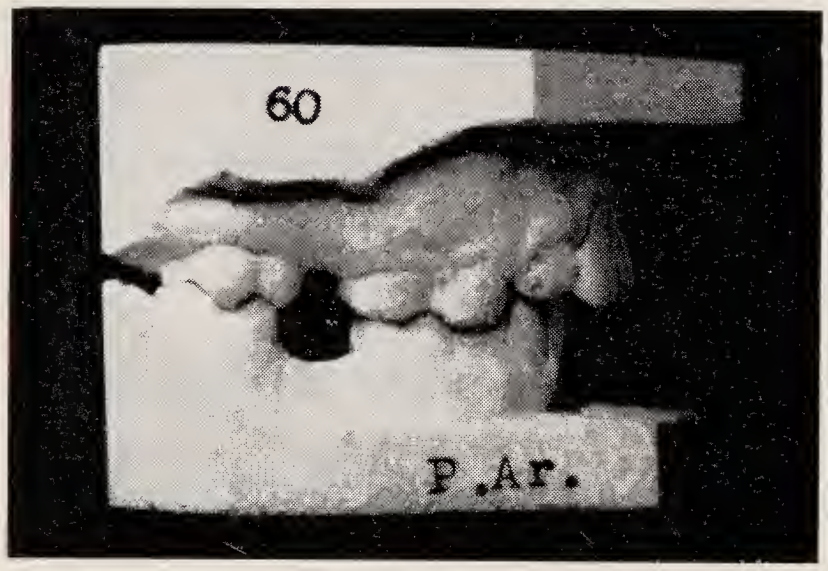



*Fig.* 14.

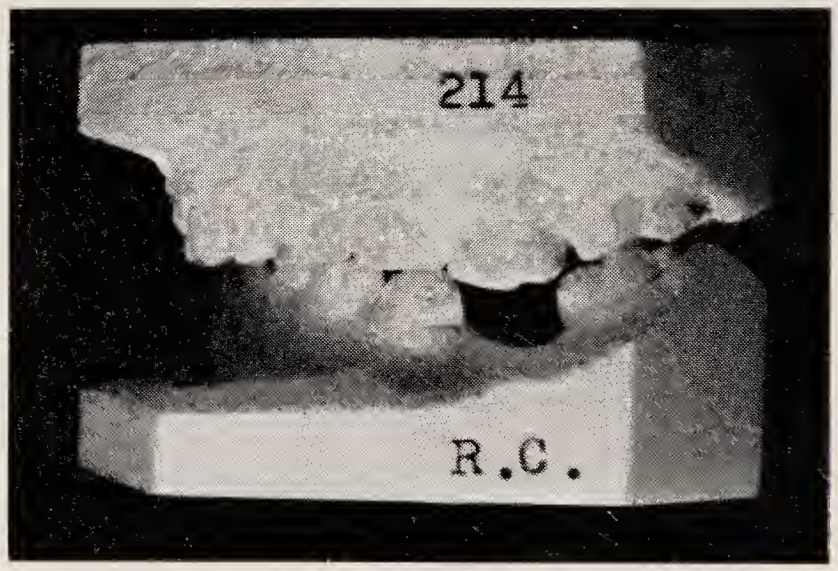



*Fig.* 15.

*Fig.* 16.

*Fig.* 10.—Case giving little opportunity for tongue bulge.

*Fig.* 11.—Case showing posterior cuspal lock.

*Fig.* 12.—Partially effective cuspal lock in spite of attrition.

*Fig.* 13.—Cuspal lock rendered ineffective by caries.

*Fig.* 14.—Case showing secondary cuspal lock of permanent molars.

*Fig.* 15.—Weakening of cuspal lock by tilting of lower molar.

*Fig.* 16.—Weakening of cuspal lock by tilting of upper molar.

Case 352 (*Fig.* 7), $1\frac{1}{4}$ years after loss of $\overline{DE|}$. Tongue bulge has apparently been effective, in spite of strong lip pressure.

Case 381 (*Fig.* 8) shows diversion of tongue bulge by additional extractions in the lower arch, reducing its effectiveness above. In Case 228 (*Fig.* 9), both sides of which are shown, the lower E space has been better maintained on the left side, in spite of earlier extraction. This I ascribe to diversion of the tongue bulge on the right side; though cuspal lock on the left may also have helped. A poor combination from the point of view of tongue bulge (though, as Hopkin pointed out in 1958, not necessarily from that of cuspal lock) is shown in Case 375 (*Fig.* 10).

Cuspal lock is probably not often fully effective in the late deciduous dentition, owing to attrition. Partial effects may, however, be seen, as in Case 601 (*Fig.* 11), which was noted as "partially effective posteriorly". In Case 212 (right) (*Fig.* 12) there seems to have been some effect, in spite of attrition, though the long interval since extraction has produced considerable total space loss. The action of caries in destroying what might have been a useful lock is seen in Case 338 (*Fig.* 13), where the carious distal surface of $\underline{D|}$ is unable to engage the slightly over-erupted $\overline{E|}$.

A secondary lock may be formed at a later stage, as in Case 60 (*Fig.* 14), where the upper first permanent molar, having achieved a stable Class II articulation, can now be restrained by the lower first molar. Too often, however, such a lock is weakened by tilting of the lower molar (Case 214, *Fig.* 15), or the upper (Case 212 left, *Fig.* 16).

## DIFFERENCES BETWEEN LEFT AND RIGHT SIDES

(*Fig.* 17)

We now turn to the second and, I venture to hope, more interesting part of my paper. At any rate we shall be picking our way across a new and largely uncharted field, and I hope to share with you some of the fascination I experienced in exploring it.

In the 1951 study, note was taken of the differences between left and right sides, and in the case of the second deciduous molar there seemed to be a tendency for space to be lost more rapidly on the left side. I suggested at the time that this might accord with the conception of the left side of the body as the

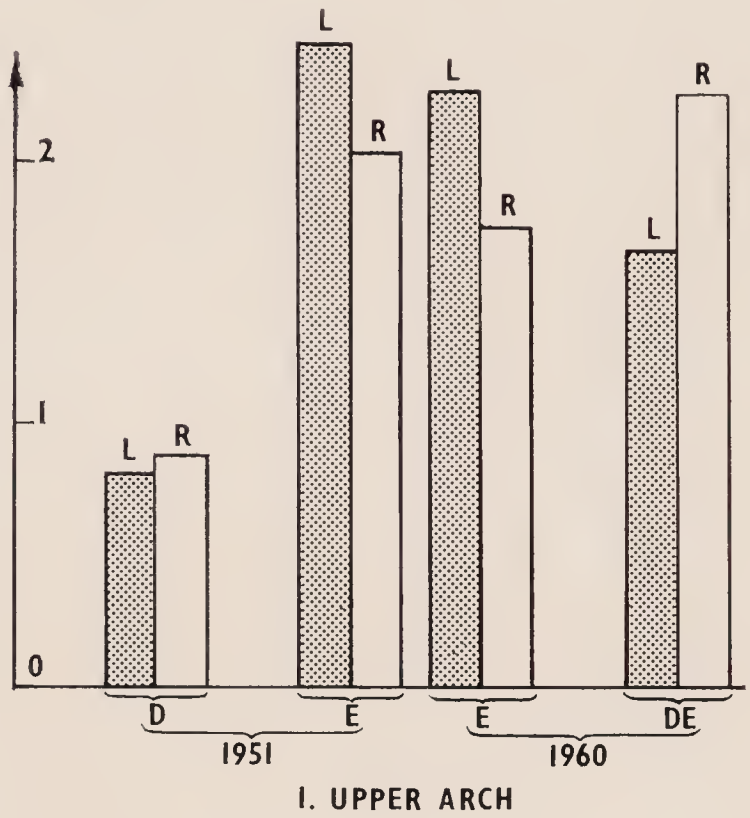



*Fig.* 17.—Differences between left and right sides (after correcting for "social" left-handedness). Mean rate of space loss in mm. per year.

"weaker" side. I also noted, however, that in the small number of double extraction cases then available, the reverse seemed to be the case. This was the other aspect of the subject which I wished to follow up in particular.

It can be seen from the graph that the space loss is again more rapid on the left side in the upper and lower E groups, though with random

differences from the earlier results, and less marked in the lower arch. As explained earlier, the 1960 figures are to be preferred. In the double extraction groups, however, space is lost more rapidly on the *right* side, thus confirming what was suspected in 1951, subject to some statistical qualification. This effect is seen more clearly in the lower arch, and it seems possible that the same factor which is responsible for the checking effect in the lower DE group generally may also be responsible for the additional checking of space loss on the left side in this group. This, in fact, appears to be borne out by subsequent investigation; but as the field is a new one, some introduction must first be given.

The distribution of primary extractions between the two sides was fairly even, except in the upper DE group, which had a preponderance of extractions on the right side (16 right against 11 left). This does not affect the means shown here, but has a slight effect on the average for the whole group, as pointed out earlier.

Looking for some unknown anatomical or physiological factor affecting the "dominant" side more (or less) than the other, I had felt initially that the first step was to sort out the left-handed children and transfer them to the opposite side. The graph therefore refers strictly to the dominant and non-dominant sides, and remarks affecting the right-handed majority must be reversed for the left-handed minority.

Of the 102 cases in the sample, 9 were found to be left-handed by simple questioning. This agrees with the estimates of other workers; but it relates to what may be termed "social" left-handedness. It is known, however, that a number of "genetically" left-handed children (as determined by hair-whorls, etc.) become socially right-handed, either through education or imitation (Eustis, 1949, and others). The proportion of true left-handedness (known as sinistralism) is therefore higher than 9 per cent; estimates vary from about 17 per cent upwards (Friedman, Golomb, and Mora, 1952; Woo and Pearson, 1927).

We may therefore suppose that an unknown number of genetically left-handed children (possibly as many as 9 or 10) were included on the right-hand side of the investigation as determined by questioning. These would tend to obscure the real differences present.

The importance of this is statistical. The difference in mean rate of space loss on left and right sides in the lower DE group is subsignificant (1·7 times the Standard Error); but for those who have qualms about accepting this level of significance, I would suggest that, if the true proportion of sinistralists were known and allowed for, conventional significance would probably be reached. It is also worth noting that this tendency had been observed in a small group in 1951, and the addition of these cases to the present material would also raise the level of significance.

## POSSIBLE EXPLANATIONS

If these differences are not due to chance, some explanation must be sought: why, in cases of double extractions, should the space loss be less rapid on the left side? Five possible theories suggest themselves; there may be others. I will examine each in turn.

**1. Theory of the Biological Inferiority of the Left Side.**—This was the first possibility to which I turned. The inference would be that the left side is a little more plastic than the right; hence more easily affected by adverse forces, but by the same token, more responsive to a restoring force such as the tongue. This theory once had a considerable following, but now seems to be out of fashion. A strong argument in favour of it is the fact that cleft palates occur twice as frequently on the left side as on the right (Glass, 1959).

Unfortunately, the theory seems to break down if pressed. Preferences and "dextralities" undoubtedly exist, and have been related to a dominance of one side of the cerebral cortex over the other (Peterson and Fracarol, 1938); but these distinctions are by no means absolute (Woo, 1928; Wevill, 1928), and there is great power of adaptation and transference following injury (Bethe, 1932). Perhaps the strongest argument against it is the fact that, on the average, the right eye is no better than the left eye; and that where an ocular preference is evident, no correlation

ean be found between oeular and manual dextralism (Woo and Pearson, 1927).

**2. Theory of Differential Tongue Activity.**—If it eould be shown that the tongue museles were normally stronger or more aetive on the left side, the results would be explained. Unfortunately, however, the only investigators of the subject, so far as I am aware (Block, Disher, and Froesehels, 1957), found that right-handed people were right-tongued; the congruity observed (70 per eent) being greater than that for foot, ear, or eye dominanee.

It may be asked, why does this not have a greater effect? The answer may be that every museular action is aeeompanied by a reeiproeal thrust somewhere, and there may be a reeiproeal bulge on the non-aetive side whieh eaneels out the primary effeet. Froesehels (1960) also notieed that loeal faetors, sueh as prostheses, may affect the tonguedness, and this may be relevant in reverse.

**3. Theory of Differential Eruption of Premolars.**—We know that the vigour with whieh the premolars erupt is eapable of reopening some of the lost spaee. To aeount for the differences observed, the premolars would have to erupt earlier on the left side. Braeeesi (1960a, b) found, however, that in normal ehildren eruption times were symmetrieal on left and right sides. In ehildren with abnormalities, eruption was asymmetrieal, but it was irregular, following no elear pattern.

**4. Theory of Differential Incidence of Tongue Diversion.**—If additional extractions oecurred more frequently on the right side, the tongue bulge might be weakened by diversion on that side more often. Salzmann (1937) has observed a slight difference in the frequeney of extraetion of first permanent molars on the two sides; but so far as my sample was eoneerned, diversion of tongue bulge oeeurred with equal frequeney on left and right sides. More recently Halikis (1960) has reported no signifieant differenee between left and right sides in the ineidenee of deciduous molar extraetions.

**5. Theory of Skeletal Asymmetry.**—So far we have sought without sueeess to find a differential eheeking faetor operating more strongly on the left side. Suppose, however, that the eheeking agent is eonstant, but its field of operation is asymmetrical; this might explain the results, and however fantastie it may appear at first sight, this is the view whieh I have eome to hold.

We are aeustomed to thinking of the tongue as a primary moulding foree; but if over-riding skeletal or museular factors intervene, the tongue beeomes a seeondary foree producing limited local effeets. In severe skeletally post-normal eases, for instanee, proelination of the lower ineisors may be seen. Clineh (1958b) and Harvold (1951) have shown the effort at adaptation in grossly abnormal cases. It seems logieal to suppose that, if some asymmetry were *normally* present, the tongue would come into eloser contaet with the dental arehes on the more inset side. The response to be expected would be some type of tooth movement; but if this were prevented by external museular foree, the effeet of eloser apposition of the tongue might be seen in a more effieient eheeking action in eases of early loss, and perhaps in a differential earies ineidenee, due to an improved seouring aetion.

This might not oeeur in every ease: since we are dealing with the mean, the asymmetries might be widely distributed but slight in degree, or more marked but eonfined to fewer eases.

Asymmetries oeeur in the body generally (an obvious example being the position of the heart); and we know, for instanee, that the right humerus is usually a little longer than the left. Harvold (1951) has demonstrated asymmetries of the skull; Berger (1957) and Jaekson (1937) have drawn attention to asymmetries of the faee. There is, however, very little material relating to asymmetries of the dental arehes themselves, and in order to examine this question I deeided to make a few simple tests.

## DENTAL ASYMMETRIES OBSERVED

My starting point was the Presidential Address given before this Society by Rix (1946). He observed that, of 27 ehildren with atypical swallowing habits, 6 showed linguo-oeelusion of upper eheek teeth on the left side, but only 1 did so on the right. I examined two representative samples of orthodontic

patients who had come under my care at different periods, in Coventry and in Birmingham respectively. I also reviewed the 102 research patients, for whom I had measured the relation of the upper and lower dental centre-lines.

The three asymmetries which I looked for were: (1) unilateral linguo-occlusion of upper cheek teeth; (2) unilateral linguo-occlusion of one or more upper incisors; (3) unilateral post-normal occlusion in substantially unmutilated cases. Note was also taken of the relative caries incidence on the two sides. The results have been classified statistically as before, but more detailed figures will be found in the Appendix. The most reliable results are shown in *Table III A*.

*Table III.*—Significance of Asymmetries

*A*

1. *Significant results* (difference from expectation more than 2 times Standard Error):
   - *a.* In 102 research patients (mean age 8 yr. 5 mth.), lower dental centre-line was displaced to the right more frequently than the left.
   - *b.* The mean displacement was 0·35 mm. to right of upper centre.
2. *Just or nearly significant results* (difference 1·9 to 2·0 times Standard Error):
   - *c.* In a group of 200, consisting of 125 practice cases (mean age 10 yr. 8 mth.) in Coventry, and 75 clinic cases (mean age 11 yr. 2 mth.) in Birmingham, unilateral linguo-occlusion of upper cheek teeth occurred more frequently on the left side than the right.
   - *d.* In the same group, unilateral post-normal occlusion of a difference of 1 mm. or more occurred more frequently on the right side than the left.
     (*N.B.*—Both tendencies were observed in both sets of cases.)

*B*

3. *Non-significant but possibly relevant results* (difference below 1·5 times Standard Error):
   - *e.* In the 125 Coventry practice cases, unilateral linguo-occlusion of one or more upper incisors occurred more frequently on the left side than the right.
     (*N.B.*—This tendency was not observed in the same degree in Birmingham; though there were many more cases.)
   - *f.* In 59 cases of asymmetry from the group of 200, caries at time of examination was a little more frequent on the right side than the left.
     (*N.B.*—This tendency was observed in all the sub-groups.)

(D.M.F. and recurrent caries figures, where available, tended to follow the same pattern in general.)

All these can be regarded as significant, if account is taken of the consistency of the sub-groups. Since the post-normal cases were unmutilated, the mean displacement of the lower centre-line to the right can be linked with the higher incidence of post-normal occlusion on the right. It was interesting to find this confirmed by our Secretary, Mr. Leighton, who kindly sent me details of 204 children in London, aged $3\frac{1}{2}$ years. He found 25 cases of unilateral post-normal occlusion, of which 20 were on the right, and only 5 on the left (Leighton, 1960).

The higher incidence of linguo-occlusion of cheek teeth on the left side agrees with Rix's findings. As will be seen in *Table III B*, which shows the less conclusive results, I found the same tendency in the upper incisor region in Coventry.

In Birmingham, however, it was not present in the same degree; but there were many more cases of this type. I formed the opinion that the different system of referring patients in Birmingham might have led to the inclusion of a larger proportion of cases due to local causes, which in Coventry might have been filtered off by the referring practitioners. These may have overlaid and concealed the smaller number due to more deep-seated causes.

Although the differences were not great enough to be significant, the initial caries incidence, in the asymmetrical cases, fitted into a pattern consistent with the view that the tongue might have a rather greater scouring action on the left side. This pattern was followed in all the sub-groups. An exception was found in the D.M.F. and recurrent caries figures for one of the sub-groups comprising linguo-occlusion of upper cheek teeth, but only in the lower arch. This may actually strengthen the interpretation, as in these cases one might expect the tongue to be less closely applied to the lower cheek teeth on the affected side, through mechanical obstruction by the inset upper arch.

## OTHER ASYMMETRIES REPORTED

We have now reached the point where a latent tendency to asymmetry has been revealed, confirmed in a number of different

places and by more than one observer. The mental pieture I have is of an upper areh whieh tends to be slightly flattened or eompressed on the left side, and a lower arch whieh is more often slewed or deviated to the right. This might be an effort to aeeommodate itself to the asymmetrieal upper areh, in whieh ease the attempt periodically fails, leading to a eross-bite; or it may arise independently.

There is seattered throughout the literature a series of observations whieh point in the same direction. Friel (1958) found the upper first permanent molar signifieantly more rotated on the left side than on the right. Lysell (1955) reported a marked differenee in the angle of the palatal rugæ on the two sides. Most important for our purposes, Lundström (1951) found two asymmetries in the maxilla, whieh he regarded as eonneeted. In an unseleeted sample of 139 boys aged 13, he found a higher frequeney of erowding on the left side, and a more forward positioning of the upper first permanent molar on the left side; the upper eentre-line being relatively eonstant. In both eases the differenee was signifieant, and of the same order of size.

This might be explained by a differential frequeney in the loss of deeiduous teeth on the two sides; but the work of Halikis already quoted, and I hope my own observations, would diseount this argument. In a personal eommunieation (1960) Professor Lundström says that in a material of 118 eases, whieh partly overlapped the series referred to, he eould find no signifieant differenee in the ineidenee of early extraetions on the two sides. There were in faet slightly *fewer* upper extraetions on the left side (53 against 57). We may therefore eliminate premature extraetions as an explanation, and aeeept the asymmetry as a basie tendeney, present before any extraetions.

In *Fig.* 18 I have shown the ehange in the pattern of left–right space loss that results if Lundström's eorreetion is applied. His figure for the average inerease in erowding on the left side was 0·45 mm.; and this has been applied as a negative eorreetion in eases of primary extraetions in the upper left quadrant. It does not apply in reverse as, when extraetions were on the right side, the eontrol measurements were made direetly on to the teeth, and would not be affeeted. In short, in any future work on these lines, one must assume that the upper left quadrant starts

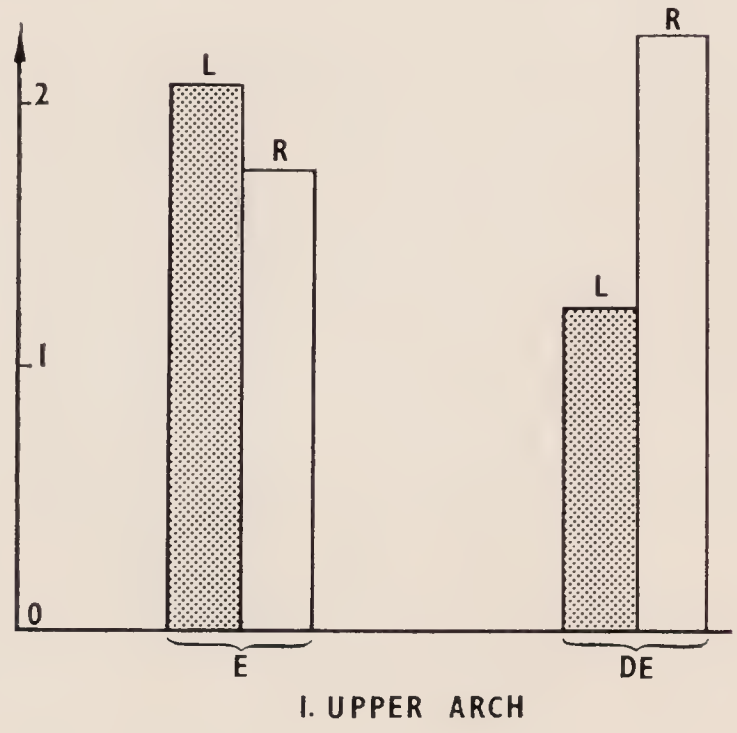



*Fig.* 18.—Differences between left and right sides, after applying Lundström's correction, using 1960 figures only. Mean rate of space loss in mm. per year.

with an average "handieap" of 0·45 mm.; perhaps this is a potential bias, whieh shows itself when areh pressures are released by loss of a deeiduous molar. At any rate, it must be taken into aeeount.

The effeet of the eorreetion is to lower the mean rate of spaee loss due to the extraetion itself. The 2 "left" eolumns in the upper areh are depressed, leaving the other 6 eolumns

unchanged. It will be noticed that the patterns of upper and lower arches now resemble each other more closely. There is now little difference between left and right sides in the case of single extractions; but in the case of double extractions, when new forces come into play, the difference in favour of the left side is marked. The difference in the upper DE group is still less than in the corresponding lower group, but it now just comes within the range of sub-significance.

This to me represents the heart of the matter. When all known influences have been allowed for, we are left, I hope, with a clear picture of an asymmetrical field within which a checking force, presumed to be the tongue, can operate under suitable conditions. As might be expected from its anatomical position, this differential checking action by the tongue is more clearly manifested in the lower arch. My explanation may not be correct; but it provides a framework into which all the observed facts can be fitted, and I therefore suggest that it should stand, pending a better one.

## POSSIBLE REASONS FOR ASYMMETRY

It would not be right to conclude without some speculation as to the reasons for the asymmetries which appear to be normally present.

Lundström could offer no explanation, but postulated environmental factors, as yet unknown. One which might occur to us is early

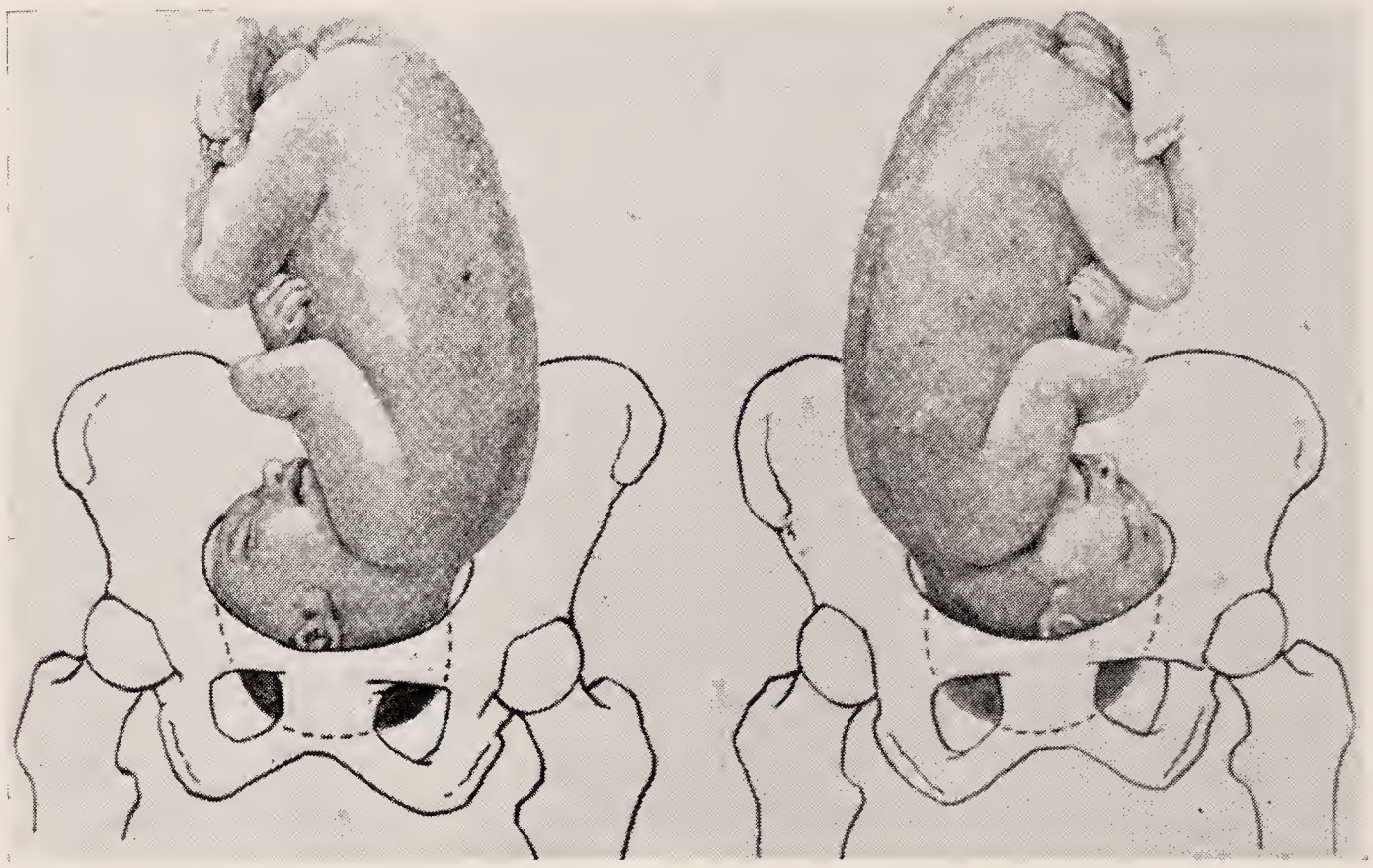


*Fig.* 19.—Commonest types of birth presentation. Vertex presentation, A, First position (L.O.A.); B, Second position (R.O.A.). (*From Eden and Holland's "Manual of Obstetrics", by courtesy of Messrs. J. & A. Churchill.*)

thumb-sucking; but Leech (1958), Lundström (1958), and others discount its permanent effect, and in more than half of Leighton's cases of unilateral post-normal occlusion, digit-sucking could not be the explanation. Leighton himself says (1953): "One is tempted to believe that these habits only maintain a relationship of the dental arches that was present very early in life, if not at birth." This I believe to be very near the truth (*Fig.* 19).

Vertex presentations constitute the great majority of all labours, and the two commonest types are shown here. The first position (left occiput anterior) occurs in 53 per cent of vertex presentations, and the second position (right occiput anterior) in 21 per cent. The first position is thus more than twice as common as the second. The importance of this is not in the birth itself, but in the fact that this position is taken up some 6 to 8 weeks before birth, according to my medical colleague Dr. D. R. Patchett, to whom I am indebted for advice on this (1960).

Dr. Patchett points out that the uterus is presumably moulded to the bony cavity in which it lies, and that the mother's spinal column presents a marked bony prominence in the posterior wall of this cavity. In the illustrations, it must be imagined as out of sight behind the fœtus, which is here seen from the front. In the first, or commonest, position, the left cheek of the fœtus is in juxtaposition to the sacro-lumbar prominence, and the possibility of a limiting pressure, once a certain stage in development had been reached, can be conceived. In the second position, any such pressure would be on the right cheek. The possibility of some such influence at a late stage of fœtal life appears to be conceded by various authorities, including Drew-Smythe, quoted by Trevor Johnson (1947), and Hamilton, Boyd, and Mossman (1945).

This view, however, does not depend on mere conjecture. In a very interesting report published in 1949, Miss Clinch correlated the type of birth presentation with flattening of the maxillary arch at ages from $1\frac{1}{2}$ to 5 years. In 38 first-position cases, she observed flattening on the left side in 9 cases, but on the right side in only 1. In 28 second-position cases, flattening was seen on the *right* side in 5 cases, but on the left in only 2. Ignoring the cases which were apparently unaffected, the correlation appears to be very strong, though not quite perfect.

This is by no means the whole story. There is in Miss Clinch's series an unexplained residuum of cases with a bias towards flattening on the left side, and it would be wise to admit that we know very little about pre-natal and early post-natal influences. Gesell (1941) attaches great importance to the "tonic neck reflex", which, he states, "dominates the waking life of the infant for some twelve weeks". This may create intrinsic muscular pressures operating more on one side than the other. He was able to trace this reflex as far back as the 28th week after conception. In both pre-natal and post-natal subjects, a strong preference for a right-handed type of behaviour was noted (Gesell and Ames, 1947). It may be that the final birth position is itself brought about by a right- or left-handed pattern of behaviour during the earlier period of free movement, chance sometimes causing a right-handed baby to settle into a left-handed birth position, or vice versa; this might account for some anomalies.

Finally, the apparent swing of the mandible to the right may be initiated in the first 2 weeks after birth, most of which is spent sleeping on the right side. This is the position of greatest comfort, especially after a feed, since it takes weight off the heart; and for this reason newborn babies are normally laid on the right side by the nurse. After watching a number of babies of up to 2 weeks old, I felt that gravitational action of the tongue might perhaps play an appreciable part during that period.

There is, of course, no end to the possibilities of speculation; but I hope I may have opened up a new field of interest and further study for members of this Society.

## SUMMARY AND CLINICAL COMMENTS

Using the method of cross-sectional study prior to the eruption of premolars, it has been shown that the mean rate of space loss, when two adjacent deciduous molars are extracted simultaneously, is significantly less than might be expected from a consideration of the effect of extracting the constituent teeth singly. There is in fact no evidence that the ill-effects are usually any greater than when one second deciduous molar is extracted alone. Certain associations with tongue behaviour and cuspal lock have been pointed out, and the most favourable results were observed in the lower arch. The checking effect was found to operate more efficiently on the subject's non-dominant side (usually the left), and the explanation of this is thought to be the presence of a tendency towards skeletal asymmetry, which is to be regarded as normal for the human race.

The precise clinical applications will depend on how far the conclusions reached can be generally accepted. For those who feel that a coherent pattern has emerged, the implication would seem to be that the second deciduous molar should be regarded as the key tooth in

the deciduous and early mixed dentition. Once this tooth is condemned, it would appear to be advantageous, in most cases, to remove the adjacent first deciduous molar as well, so as to allow natural space-maintaining forces more play. This policy can be followed with more confidence when the extractions are in the lower arch, and results will often be better on the left side (in right-handed patients). It would perhaps be wise not to go further than that at present; but a study of local conditions in each case may influence prognosis.

Two points must be emphasized. Unplanned extractions are still to be deplored; and our present knowledge is so limited, in relation to the high variability in response, that it is still necessary to follow through each case individually to determine whether a space retainer may become necessary. It is hoped that further study of the material will throw more light on the associated aspects in due course.

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I would also like to thank Messrs. J. & A. Churchill for permission to show the illustrations of birth presentations, and Mr. Richard Bailey of Coventry for the photographs and slides.



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## STATISTICAL APPENDIX

The principal figures referred to in the text are given below:—

**1. Mean Rate of Space Loss** (*Fig.* 6).

*Upper arch*: D group (1951): 0·83 mm. per year
E group (1951): 2·24 mm. per year
E group (1960): 2·03 mm. per year
DE group (1960): 2·02 mm. per year (corrected to 1·95)

*Lower arch*: D group (1951): 0·91 mm. per year
E group (1951): 1·68 mm. per year
E group (1960): 1·69 mm. per year
DE group (1960): 1·27 mm. per year

*Number in each group* (1960 only)

Upper E group: 24 — Upper DE group: 26
Lower E group: 27 — Lower DE group: 25

*Standard Deviation in each group* (1960 only)

Upper E group: 0·97 mm. per year
Upper DE group: 1·61 mm. per year
Lower E group: 1·11 mm. per year
Lower DE group: 1·82 mm. per year
(to obtain Standard *Error*, these values should be divided by 5 approximately)

**2. Clinical Observations** (*Table II*).—

*a. Frequency of "good" and "poor" cuspal locks* (excluding doubtful cases)

Upper E group: "Good", 3; "Poor", 20; Total 23
Upper DE group: "Good", 6; "Poor", 19; Total 25
Lower E group: "Good", 11; "Poor", 16; Total 27
Lower DE group: "Good", 13; "Poor", 12; Total 25

*b. Frequency of "tongue bulge" (active or passive)* (excluding doubtful cases)

Upper E group: observed in 10 out of 20 cases (50 per cent)
Upper DE group: observed in 17 out of 20 cases (85 per cent)
Lower E group: observed in 16 out of 25 cases (64 per cent)
Lower DE group: observed in 17 out of 21 cases (81 per cent)

*c. Frequency of "diversion" of tongue bulge* (actual or potential) (i.e., frequency of additional extractions in *opposing* quadrant)

Upper E group: recorded in 18 cases out of 24
Upper DE group: recorded in 13 cases out of 26
} 31/50 (62 per cent)

Lower E group: recorded in 8 cases out of 27
Lower DE group: recorded in 5 cases out of 25
} 13/52 (25 per cent)

*d. Comparison of cases with and without tongue bulge* (lower E group)

*With* bulge: 16 cases. Mean rate of space loss: 1·35 mm. per year
*Without* bulge: 9 cases. Mean rate of space loss: 2·27 mm. per year
*Standard Deviation*: with bulge: 0·70 mm. per year (÷4 to give S.E.)
*Standard Deviation*: without bulge: 1·45 mm. per year (÷3 to give S.E.)

*e. Comparison of cases with "good" and "poor" cuspal lock* (lower DE group)

*Good lock* cases: Mean rate of space loss: 0·91 mm. per year (13 cases)
*Poor lock* cases: Mean rate of space loss: 1·60 mm. per year (12 cases)
*Standard Deviation*: good lock cases: 1·97 mm. per year
*Standard Deviation*: poor lock cases: 1·55 mm. per year

*f. Influence of Diversion of Tongue Bulge* (upper DE group)

Mean rate of space loss for diverted cases: 2·25 mm. per year
Mean rate of space loss for non-diverted cases: 1·79 mm. per year

*g. Influence of type of swallowing behaviour* (as observed by palpation of masseter muscle) (lower DE group cases *with* tongue bulge)

Mean rate of space loss with teeth-together swallow: 0·46 mm. per year
Mean rate of space loss with teeth-apart swallow: 1·29 mm. per year
*Standard Deviation*: T.T. swallow: 0·84 mm. per year (8 cases)
*Standard Deviation*: T./A. swallow: 1·61 mm. per year (9 cases)

**3. Asymmetries** (*Table III*).—

*a. Displacement of dental centre-line.* Of the 102 research cases, the lower dental centre-line was displaced (relatively to the upper) as follows: to the left, in 31 cases; to the right, in 46 cases; the remaining 25 cases having no displacement. Additional extractions were symmetrically disposed. (Mean displacement 0·35 mm. to right.)

*b. Unilateral linguo-occlusion of upper cheek-teeth*:

*Coventry*: Number examined: 125. L-O on left: 5 cases. On right: 2 cases
*Birmingham*: Number examined: 75. L-O on left: 2 cases. On right: 0 cases

*c. Unilateral post-normal occlusion* (substantially unmutilated cases):

*Coventry*: Number examined: 125. P.N.O. on left: 4 cases. On right: 9 cases
*Birmingham*: Number examined: 75. P.N.O. on left: 1 case. On right: 3 cases

*d. Unilateral linguo-occlusion of upper incisors*:

*Coventry:* Number examined: 125. L-O on left: 10 cases. On right: 5 cases
*Birmingham:* Number examined: 75. L-O on left: 13 cases. On right: 12 cases

*e. Cavities at time of examination* (asymmetrical cases only):

*Coventry:* "cheek-teeth" group: 11 on left side. 18 on right side
*Birmingham:* "cheek-teeth" group: 2 on left side. 3 on right side
*Coventry:* "post-normal" group: 15 on left side. 18 on right side
*Birmingham:* "post-normal" group: 2 on left side. 6 on right side
*Coventry:* "incisor" group: 22 on left side. 23 on right side
*Birmingham:* "incisor" group: 21 on left side. 24 on right side

**4. Differences between Left and Right Sides (Amended)** (*Fig.* 18).—

| *Group* | *Side* | *No. of cases** | *Mean rate of space loss* | *Standard Deviation* |
|---|---|---|---|---|
| Upper E | Left | 13 | 2·07 mm. per year | 0·86 mm. per year |
| Upper E | Right | 11 | 1·75 mm. per year | 1·03 mm. per year |
| Upper DE | Left | 10 | 1·23 mm. per year | 1·82 mm. per year |
| Upper DE | Right | 16 | 2·26 mm. per year | 1·42 mm. per year |
| Lower E | Left | 14 | 1·79 mm. per year | 1·20 mm. per year |
| Lower E | Right | 13 | 1·59 mm. per year | 0·98 mm. per year |
| Lower DE | Left | 13 | 0·70 mm. per year | 1·55 mm. per year |
| Lower DE | Right | 12 | 1·89 mm. per year | 1·88 mm. per year |

* After correction for "social" left-handedness.

## *DISCUSSION*

*The President* congratulated Mr. Breakspear on doing a research of that size while he was mainly engaged in private practice. It was quite amazing. He hoped that it might stimulate one or two other members who were in private practice to produce some form of research.

The President then called on Mr. A. C. Campbell to open the discussion.

*Mr. Campbell* said: I would like to thank Mr. Breakspear for his paper, for bringing to our notice the results of much painstaking effort, and also for delving into regions far removed from our field of activities to seek explanations for some of his findings.

He has given us evidence to show that there is no greater rate of space loss when two adjacent deciduous molars are extracted simultaneously, than when a second deciduous molar alone is removed. Over the whole series of cases, however, the difference in rate of space loss is not statistically significant. When he analyses the rates for left and right sides, however, differences are shown which come within the range of statistical consideration, and may possibly be considered significant. From a clinical point of view, of course, as Mr. Breakspear suggests, we must consider each case individually both in advising extractions, and possibly in advising space maintainers, but I think that we shall want to consider the whole matter most carefully before advising the removal of a sound lower left first deciduous molar in a right-handed child, at the same time as a second deciduous molar, which has to be removed because of caries.

Mr. Breakspear has described various "checking" factors which would tend to reduce the rate of space loss, but I wonder if he was able to note any correlation with general physique and vitality. For want of a better term —Was the rate of space loss in any way allied to good or poor growth potentials? In this connexion, I think it would be of value to know something of the skeletal form, and also the soft-tissue morphology and behaviour. For example, we all recognize the Skeletal III type of case which frequently exhibits spacing in the lower arch. In such a case one would not expcct to see space loss following premature extractions in the lower arch. Similarly, we recognizc that the soft tissues influence the centrifugal development of the dental arches, so that at one extreme we find splaying out and spacing of the teeth, whilst at the other extreme we find crowding. We would not expect to see the same types of space loss in these two types of case.

It seems to me that there may be some additional factor at work to help explain the small rate of space loss when two adjacent deciduous molars are extracted. It has been suggested by Ballard, I think, that the lingual collapse of lower incisors is materially the same no matter which cheek teeth are extracted, so that the loss of one or two teeth should make little difference here. However, as Mr. Breakspear suggests, where two teeth have been removed it is easier for the tongue to insinuate itself into the gap and so have a better chance of holding back the first permanent molar. In the upper arch, however, he has shown the rate of space loss to be greater, and suggests that the tongue does not so readily occupy this space to hold back the first permanent molar. Is it not possible that the difference between upper and lower arches is related to the different paths of eruption which the upper and lower molars follow? We have all seen how, when they are "stacked up", the upper molars tend to move downwards and forwards with great rapidity whenever they are given the opportunity.

As far as the left–right differences are concerned, the theory of skeletal asymmetry has much to support it, and one appreciates that facial symmetry is rare. For example, it is well known that if one lateral half of a full-face photograph is mirrored to produce a symmetrical full-face photograph, the "faked" picture may well be unrecognizable when compared with the original subject. However, I feel a little doubtful about accepting the suggested causation. We would agree that, although a persistent sucking habit may produce derangements of occlusion, these will not persist when the habit is given up unless there is some other abnormality present which fosters them. I think also that we would agree that the pressures exerted are unlikely to affect either the amount or direction of skeletal growth. Similarly, I find it difficult to accept that the transient, although powerful, pressures exerted on the fœtus before, during, and after birth

can have any long-lasting effects unless there has been gross trauma. I think that it would be interesting to know something of the genetic background of the individuals showing the asymmetries, for there are many variations of the skeletal pattern which we are prepared to accept as genetically determined.—Why not asymmetries also?

It is difficult, of course, to know which is the chicken and which is the egg, but a more persistent locally acting factor might be the mechanism of mastication for the particular individual. Many people have a "favourite" chewing side, and of course in adult life in particular there may be many factors contributing to this, but Eschler did suggest from his electromyographic recordings in infants that action potentials were not bilaterally asymmetrical. It is possible that this asymmetry may persist with moulding effects upon the teeth and their supporting structures.

In conclusion I would like to thank Mr. Breakspear for letting me see the draft of his paper beforehand, and I would congratulate him on its production, for I know how much time from his practice it must have demanded of him.

*Mr. B. C. Leighton* said that he had noticed, during the course of his own researches on infants at birth, that the incidence of asymmetry at birth was not uncommon and was sometimes quite extreme. Examination of the infants subsequently showed, in the majority of cases, that that asymmetry disappeared, but that was perhaps supported by the observations of Brodie on asymmetry of the cranium at birth. Brodie noticed in some infants that the cranium was so compressed during birth that there was overlapping of the parietal and frontal bones and that that disappeared within the first six weeks after birth.

He was inclined to agree with Mr. Campbell that the influence of birth itself and pre-natal posture was probably rather a doubtful aetiological factor. He confirmed that he noticed repeatedly that post-normality occurred more frequently on the right side than the left where it was one-sided post-normality.

Did Mr. Breakspear differentiate between closure of space from the front of the mouth from closure of space by forward movement of molars? These seemed to be rather important aspects of it, that space could be closed by collapse of the incisor segment or by forward movement of the molars.

*Miss L. M. Clinch* said Mr. Campbell had queried mastication and that was a point which Mr. Breakspear had not mentioned. That might have a bearing on many of the effects after early loss of teeth; more mastication on one side would result in more attrition on that side which would interfere with the cuspal lock which must be a very big factor in retaining space.

The centre line which Mr. Breakspear had mentioned as having become displaced at 8 years of age very often corrected itself at a later stage. It was, quite often, only a temporary displacement. There was a point which Mr. Leighton had made which she also wanted to ask Mr. Breakspear about. In the lower arch one very often, after loss of teeth, got a lack of growth anterior to the extraction, whereas in the upper arch, one got a mesial drift of the teeth posterior to the extraction. It did not always work that way, but there was a difference in the two arches in the way the loss of space arose. Could Mr. Breakspear clear that point up?

*Mr. D. T. Hartley* said that Mr. Breakspear had explained that, with a normal distribution curve, any figure which differed from the mean by more than twice the standard deviation had only a one-in-twenty likelihood of occurring by pure chance. Could he say the corresponding proportion for a figure which differed from the mean by only 1·5 times the standard deviation, so that the significant results could be evaluated?

*Mr. J. S. Beresford* thanked Mr. Breakspear for his very interesting paper. When he completed the hat trick and gave his third paper, Mr. Beresford hoped Mr. Breakspear would be able to include a statistical discourse on the relevance of the degree of disproportion between the tooth size and bone size, and the age at which the deciduous tooth was extracted.

On nothing more than clinical observation, one felt that the amount of space that the teeth wanted had a lot to do with it, and the age at which the loss occurred. He was not quite sure why Mr. Breakspear had rejected the 1951 figures. If the 1951 figures and the 1960 figures were put together, there was virtually no difference between left and right side. He thought one should be careful not to construct too big an edifice on slender foundations.

*Mr. Russell* asked if Mr. Breakspear had any comment to make on the question of cuspal lock and Angles classification. There was some slight significance on the question of the dexterity of dental surgeons in general and their preference of treatment of sides. A lot of dental surgeons did not like working on one side or the other, especially in difficult cases, such as children. He did not know whether that had any bearing at all.

*Mr. Allen* asked whether Mr. Breakspear would recommend having two lower teeth extracted in a case in which he would expect the tongue to bulge in and occupy the space where the loss of one was certain.

Another speaker said that, in connexion with asymmetry, he had noticed that in cases where the arches were very short and there was impaction of the upper first molar by the upper second temporary molar, the condition was usually not symmetrical. One would find one case where a molar was so far forward that the "E" was loose—so loose that one could almost take it out, or it came out. In other cases, the impaction was very much less so one undertook extraction oneself, which was obviously necessary. He was afraid he had not noticed whether the right side was more forward than the left or the other way round. Had Mr. Breakspear ever noticed that?

*Mr. Breakspear*, in reply, said that he hoped further study would be forthcoming. He had thrown out a few ideas and had not been so heavily "sat on" as he thought he was going to be.

In answer to Mr. Campbell, it was quite right to stress the need for caution in interpretation of results. Even a difference which was significant might occur by chance; on the other hand, they knew that, in most of their working life, they had to make decisions clinically without all the evidence they would like to have in theory, and had to use their judgement sometimes: and if a thing seemed to tie up with other things and make sense, they would naturally, as clinicians, have a bias in its favour. The statisticians might think that was a wrong bias; but the universe did make sense, and things which appeared to make sense to him had a strong argument, in his mind, for acceptance pending further evidence.

There was a negative aspect of it, as he had tried to point out. Although the difference between the single

and double groups was not significant, it was always in one direction. There was no evidence that the extraction of two teeth produced a higher rate of space loss. There was a small amount of non-significant evidence in the other direction.

The other questions raised would help to explain variability. There was a big variability in the response of people to those extractions within each individual group, and he had not dealt with that at all in the study; but there was a vast mass of material which he was hoping in due course to analyse, and he hoped to have the answers later on. He would prefer not to comment on them. He had clinical notes on all those things—skeletal form, etc. It took a long time to work them out, and also to be quite sure that one was comparing two things which were comparable. One of the difficulties was that one might compare two groups where there was a common factor which overlapped another one, and consequently think that one factor was the explanation, when it was due to something else. That was found over cuspal lock and tongue bulging. It was not easy to find sub-groups which were comparable; but, if all went well, he hoped that later on he could produce something on those lines.

With regard to paths of eruption, he agreed that by its nature the upper molar appeared to be more difficult to check than the lower, which might partially explain the results.

He had been careful to say that thumb-sucking was not a primary cause and other things might be. Not much was known about it; but it was known that foundations once laid down were not easily altered, and he would not like to say offhand that those pre-natal influences could all be written off as purely temporary. It might be so, but it might not be so; and Miss Clinch's figures which he had shown, correlated with the type of birth presentation, pointed strongly to the fact that there was some connexion. More than that, one could not say.

With regard to chewing, people did have a favourite side for chewing—the side where teeth were present was more favoured anyway. He had no material on that, but he might, by inference, be able to produce an answer to that question later.

He had been careful to suggest that it was not the birth itself which caused asymmetry but the formative period before birth, going back for a month or more, which was a different thing altogether. Most of the birth asymmetries seemed to occur in the top of the skull rather than down n the facial regions. That was quite a different thing.

Direction of space closure was important and he hoped to throw more light on that in due course.

To Miss Clinch, he said he agreed that attrition might weaken cuspal lock on one side more than the other. He also agreed that centre-lines varied a great deal; he had just taken a cross-section of them as they were at the time, and some reason would have to be found why the centre-line was deviated to one side at that age. It might be that at the age of 12 it was deviated differently but some explanation was wanted. Miss Clinch's method of longitudinal study did have advantages; each method produced different information and this had to be put together. The question of upper and lower arches was something which he hoped to be able to work out in more detail later on.

To Mr. Hartley, the answer was 0·2—or one in five.

With regard to Mr. Beresford he hesitated to commit himself about age of extraction. There was a tendency for cases with very early extraction to be a little more rapid in their space loss than the older ones; the proportion was about six to seven. What *was* important was the time which elapsed. If a tooth was extracted at the age of four, it had six years for space to be lost; if it was extracted at nine, perhaps only one year. That had to be taken into account.

The 1951 figures had not been rejected; they had been qualified. In 1951, he had assumed a "blanket" encroachment of 1 mm. average for every case. That had not fitted in with other things that were known, and it had appeared to him that the encroachment factor was subject to an age variation, by which teeth extracted early had (on average) lost less interstitial substance than those extracted later. He had therefore worked out for each one a theoretical amount of encroachment, which made the new figures more precise.

He did not agree that there was no difference between left and right sides in the double group. That was so in the single group; he had tried to explain that. In the double group there was quite a big difference between left and right sides.

With regard to preference of treatment by dental surgeons, that was an interesting point and one which was new to him. He would have to think about it.

Most of the other points mentioned had been covered by his general plea for time to take note of the questions, and to see what he could do about producing answers some time in the future.

# SOME PROBLEMS FOR CONSIDERATION. I

By **R. E. RIX**, F.D.S. R.C.S., M.R.C.S., L.R.C.P.

I AM very conscious of the honour of having the opportunity of giving The Northcroft Memorial Lecture, but I must admit it has caused me some anxiety during the past few months. In the interest of prevention of cruelty to Northcroft lecturers I feel they might well be confined to whole-time teachers sustained by the facilities of their departments. For the protection of the members of the Society I would also suggest that lecturers should have had not less than four offspring to help keep their feet on the ground. I should not qualify under either of the headings. As time has passed the fascination of seeking for aetiological factors has been overshadowed for me by the more immediate problems of making treatment available where it is needed among a child population in England and Wales of $5\frac{1}{2}$ millions in the age-group of 8–15 years. To care for the shape and relationship of the dental arches so that these children may grow up with the expectation of having teeth that are presentable and as durable as the onslaughts of civilization will allow, is a tremendous task.

We have come to appreciate in broad outline the reasons for the variations seen in the dentition. We know that they are infinite, and it is pretty certain that the continued search for aetiological factors is not going to lead to the discovery of some panacea. No biochemist is going to improve the assortment of our genes, and we have not yet arrived at a stage of sufficient docility to submit to plans of the eugenist. I think, therefore, that we must begin to place more emphasis upon thoughts of making treatment more readily available and of simplifying it wherever possible.

I would like to try to make the whole subject of orthodontics less esoteric than it has become. Much will be lost if orthodontics drifts towards an isolated speciality.

Help in reversing the trend could be gained at undergraduate level, though admittedly it would take some time to become apparent. It is not easy for an undergraduate to acquire and digest the information which is now presented to him. What with teleradiology, geometry, graphs, statistics, electromyography, genetics, as well as anatomy and physiology, there are opportunities for him to be overwhelmed. The art of teaching lies in maintaining an appetite for knowledge, and at present the orthodontic diet tends to be fatty. Another difficulty is a disturbing division in the teaching of the basic sciences. What is *considered* an adequate background for the study of dental surgery is not enough for an adequate background for orthodontics, and it would be beneficial in all respects if a comprehensive syllabus could be drawn up and presented to all students. It could be done if undergraduates had the advantage of receiving their preclinical tuition in departments which include whole-time teachers in dental anatomy and physiology, with prospects of attaining the highest academic status. Teachers of high calibre need to be attracted to these appointments. They should be assisted by part-time teachers with clinical experience, including orthodontic experience. The departments would then provide the all-inclusive formative education upon which clinical training would be built no matter what the particular clinical training was; whether it was prosthetics, periodontology, orthodontics, or general dental surgery.

I cannot think of another single project which would so increase the stature and the usefulness of dental surgeons in the long run in the whole range of their activities.

The undergraduate, during his clinical training, would then not need to spend so much time listening to his various clinical teachers giving preliminary instruction in the basic

The Fourteenth Northcroft Memorial Lecture given at the meeting held on November 14, 1960.

sciences relating to their own particular speciality and he would be saved from conducting himself as though dentistry were a conglomeration of disjointed specialities.

When he enters an orthodontic department he should already know something of the points to look for in an assessment of a derangement of the dentition. His preliminary training will have made orthodontics more digestible. It will, I think, avoid some of the tidy mathematical concepts which beguile the unwary student into believing that the dentition should be made to fit. The subject will take its place logically among other subjects without unnecessary re-orientation of ideas.

Proper basic tuition would leave more time available for him to examine with his clinical teachers the innumerable variations to be met with at orthodontic clinics, and to appreciate what conditions are worthy of treatment, what improvements are desirable or possible, and to plan ways of achieving them. Courses of lectures in orthodontics are a help to orderly thinking and orderly replying to examination questions, but they go in one ear and out of the other in the absence of adequate chairside instruction.

Time would also be available for the designing of appliances and the actual treatment of patients under supervision. By his own efforts the undergraduate should sense the response of teeth to pressures which he has applied himself. It promotes interest and encouragement. I have seen too many useful people turned out by undergraduate schools to agree with those who would prefer that orthodontics should be solely a postgraduate study. I agree entirely with the observations which were made before this Society (Hovell, 1956).

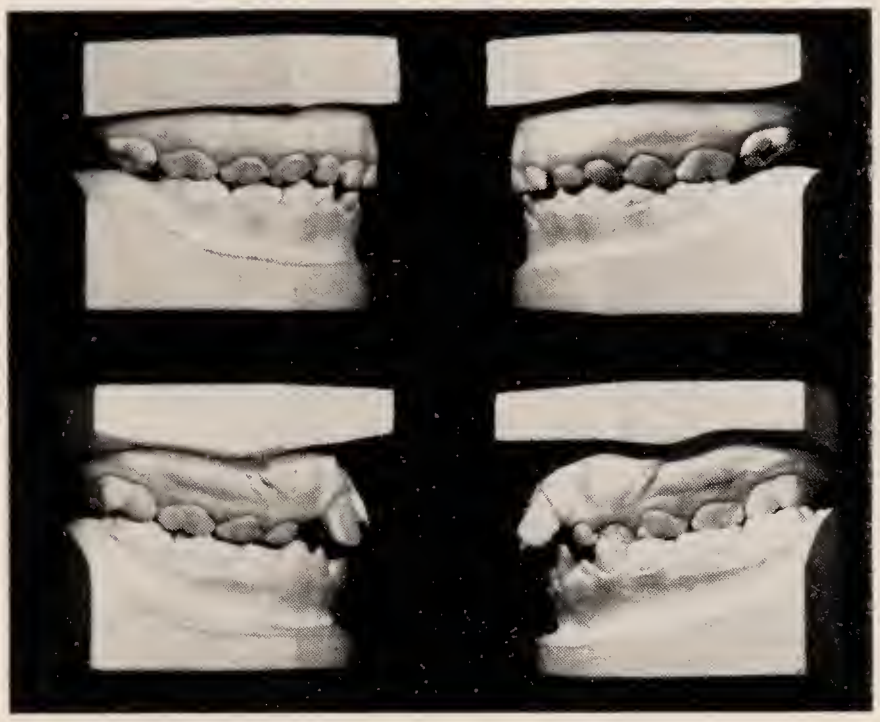
The country is beginning to be dotted with orthodontic consultants, an important part of whose duties is to provide what, in essence, is postgraduate instruction for those who seek it. Quite apart from any formal talks or demonstrations that consultants have the opportunity to give, there are many chances of amplifying bare statements of treatment plans in letters of advice with explanatory asides. Consultants' letters covering a course of treatment over a period of two years can be time consuming, but they are extremely valuable. The more revealing they are the less frequently in the end will practitioners need to seek advice upon similar malocclusions.

As far as I can see the main hope of improving the spread of orthodontic treatment for deserving cases lies in the well-informed general practitioner. He is accessible, geographically speaking. He is the best judge of the desirability of treatment in all the circumstances; he has the best opportunity of instigating treatment at the most advantageous time; he continues to look after the teeth during treatment and he has to live with the mouth after treatment is finished. I also like to think he would prefer not to allow the range of his activities to shrink.

The diversity of treatment that can be carried out with removable appliances is very considerable, providing they are designed and handled with precision and providing the onset of treatment is well timed. Their potential has probably not been fully exploited and it is also probable that opportunities are sometimes missed to change tactics which would permit removable appliances to be used instead of fixed ones to produce a satisfactory result. To enlarge the scope of removable appliances gives the general practitioner and his technician the chance to stay on more familiar ground. There is no hope of working up expertise in treatment with fixed apparatus. Such treatment requires postgraduate training.

Another easement seems to be possible for those at undergraduate level. I am inclined to think that it is easy to overburden the subject with observations under the heading of soft tissue behaviour and dental base relationship. I have taken a great interest in the soft tissue environment of the dental arches and have tried to keep up with the literature. Most of us are satisfied that it makes a contribution to the shape and relationship of the arches (*Fig.* 1), but its subtleties are difficult to understand. While we are still in the process of clarifying our ideas, as I think we are, I would not want to lead an undergraduate too far into this subject.

Examination eandidates from undergraduate schools are often mueh confuscd. How often havc I listened to thcm voluntcering the information that the cireumoral muscles show rest, and therefore apart, the relatively short upper lip does not provide adequate coverage of the upper incisors (Ballard, 1956). This lack of coverage in the presence of



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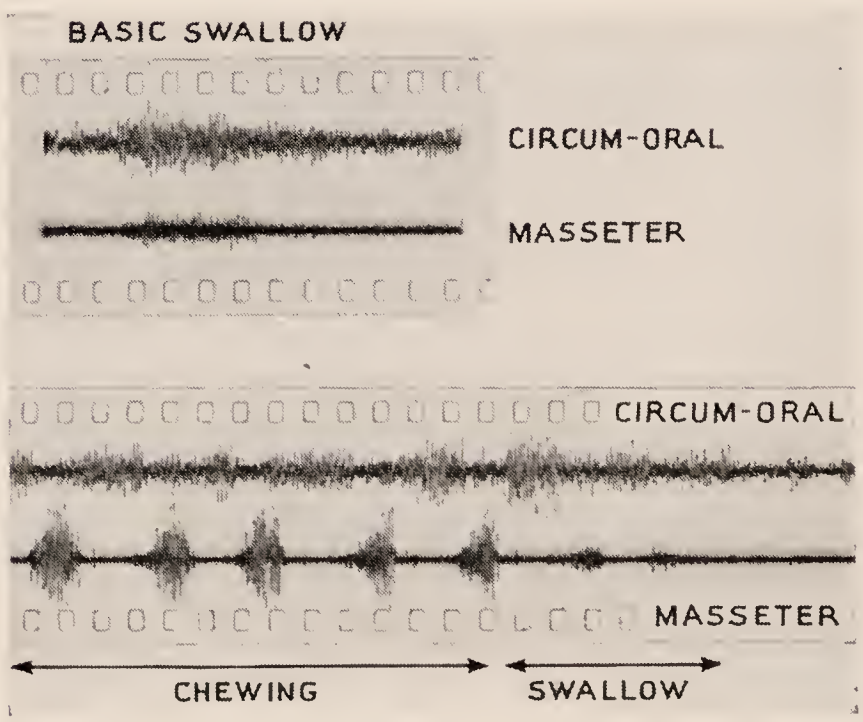


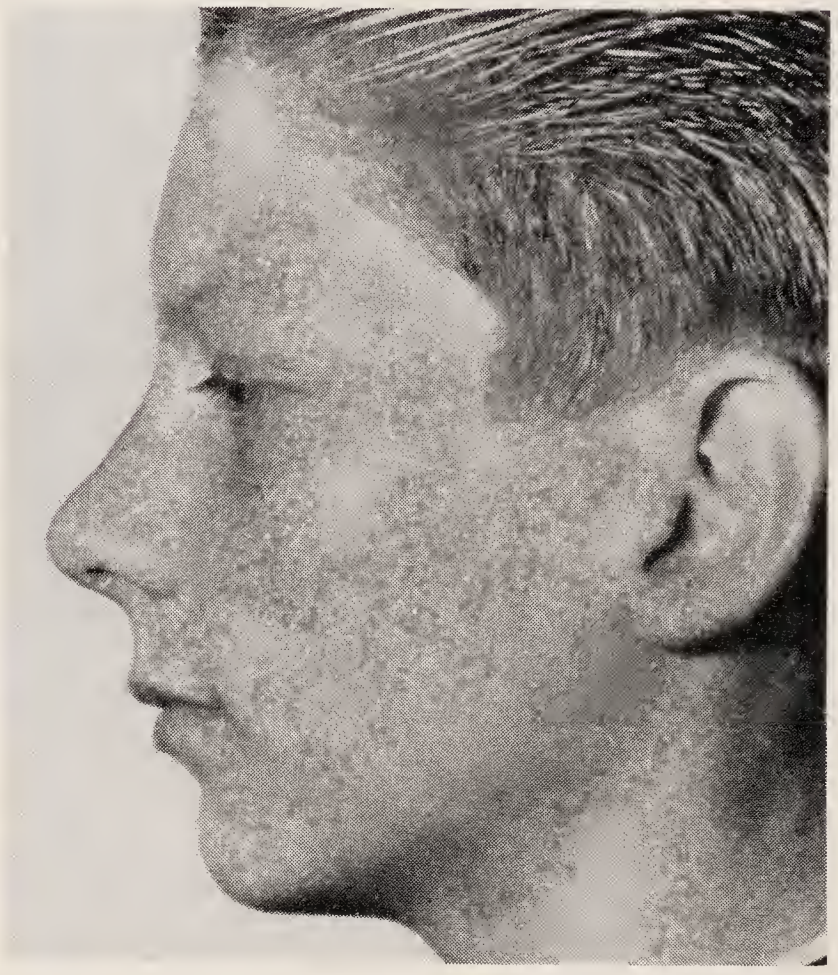

C

*Fig.* 1.—A, B, Lateral and occlusal views of case showing the effect of an adverse soft tissue environment on the dentition as it changes from the deciduous to the mixed dentition. C, Electromyogram of this case indicating the tooth-apart swallow with the circumoral contraction.

exeessive contraetion in Class II, division 2 eases when I cannot see it. I know they are arguing backwards, beeause the upper central ineisors are retroclined. They forget that one would equally expect to find the upper central incisors to be retroclined without excessive contraction if the front of the lower arch is relatively retruded. I have often heard talk of a poor prognosis of a ease with an overjet with its expeeted commensurate degree of overbite, because of a tongue thrust during swallowing, whieh will not, in fact, prevent correction. There is also confusion over the effects of incompetent lips. The literature is conflicting on the point, especially in this exploratory period when hypotheses have to be abandoned from time to time. There is one which is current which I find difficult to follow. It is that an overjet is ereated by a eombination of two sets of eireumstances. First, when ineompetent lips are sealed, the contraction of the mentalis muscle causes the lower ineisors to be more lingually inclined than they otherwise would be. And seeondly, when the lips are at anteroposterior crowding permits, it is said, the upper incisors to be more proclined than they otherwise would be. But one sees Class I cases with an overjet with no anteroposterior crowding when lips are incompetent. The explanation does not seem to take into eonsideration all the circumstances. These children

separate their teeth during swallowing. The front of the tongue is moved forward over the lower incisors, with its ventral surface making contact with a contracted lower lip while its dorsal surface lies against the palatal surface of the upper incisors. A situation then arises when it is feasible to think that an overjet can be created. The front of the tongue is not lying behind the lower incisors. They have lost its support. It has been moved forwards and support has been transferred to the upper incisors. The mentalis-assisted lower lip, in contact with the ventral surface of the front of the tongue, is pressing back against the unsupported lower incisors. These conditions are the same as those I once described during that variety of swallowing behaviour with teeth apart which I called the infantile type (Rix,

A



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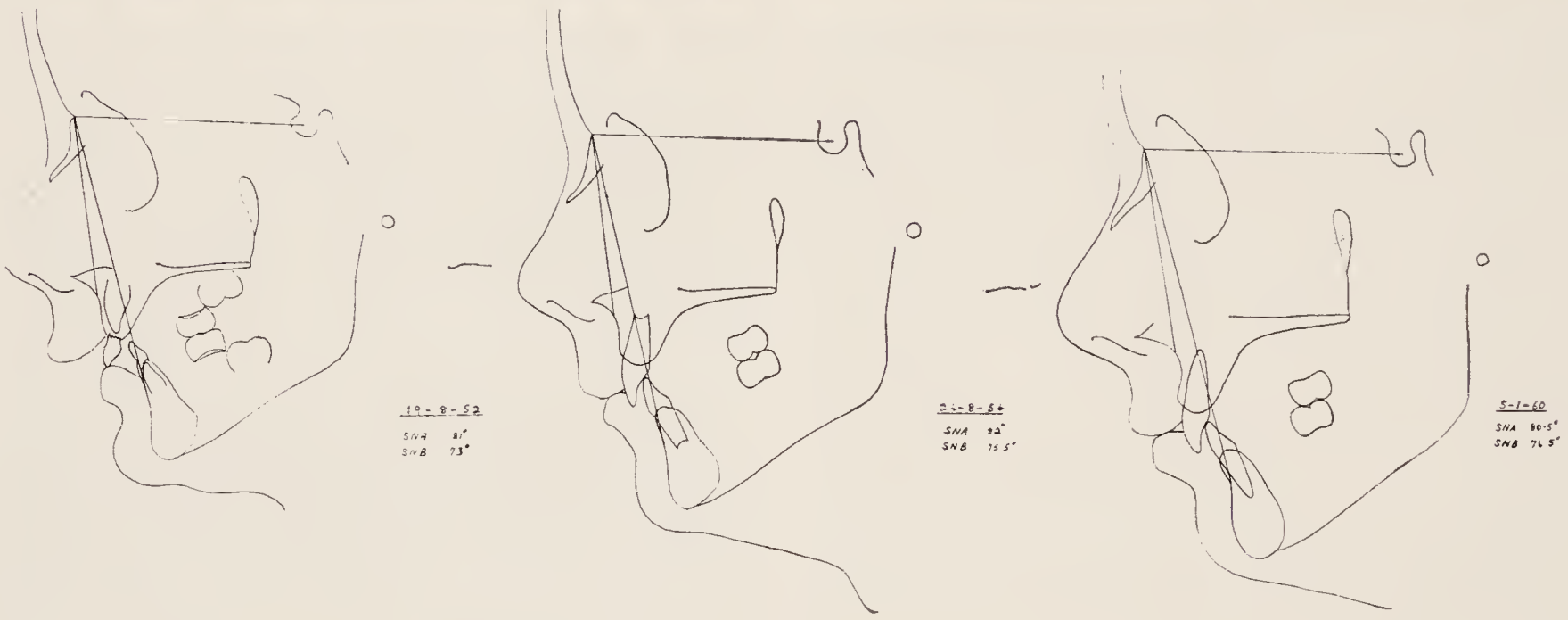


C

*Fig.* 2.—Profile views of patient in A, 1952, and B, 1960, showing considerable improvement in lip posture with the passage of time and the correction of a Class II malocclusion, using the Andresen monobloc. The general behaviour of the oro-facial muscles in swallowing was noticeably improved. C, Lateral X-ray tracings of this patient.

1946, 1952), and which Gwynne-Evans and Tulley (1955) called the visceral type. I like their phrase. The combination of incompetent lips and of swallowing with the teeth apart, which produces repeated and quite forceful pressures, is likely to create more disturbance in the incisor relationship than any that can be deduced from the behaviour of incompetent lips alone.

Are we right in assuming that incompetent lips will always remain incompetent? It would be valuable to discover by scientific method whether the effort to seal such lips ever at least becomes less (disregarding any reduction of effort which would follow treatment to improve the anteroposterior incisor relationship). A reduction of effort would presuppose some change in lip morphology. From clinical observations I would say that effort does become less sometimes. The boy illustrated in *Fig.* 2 revealed no effort by the time he was $13\frac{1}{2}$ years old.

I would like to be able to clarify another problem, which is perhaps only a question of terminology. There is the child who does not necessarily have incompetent lips, but who habitually maintains a contact between the tongue and the lower lip. The contact makes for no economy of effort in maintaining a lip seal, as one sees in operation in a child with incompetent lips. It is not a trick to sustain a lip seal. It hinders occlusal rise of the incisors. There is an anterior open bite with a varying degree of overjet. During swallowing, the cheek teeth are almost invariably separated and the tongue thrusts forcibly against the lower lip, which is tensed to counter the thrust. There is a frequent tendency to lisping speech. This is the tongue behaviour that Ballard (1955) has called "the endogenous tongue thrust", but since the tongue's resting position is in contact with the lower lip should one characterize the anomaly as a *thrust*?

When comparing this behaviour with the visceral type it seems to be a step more removed from the precision of normal behaviour, and creates a more unfavourable environment for the incisors. The term "endogenous tongue thrust" fixes a label on an isolated sign and shuts the door on a broader view. A sign is highlighted in an ontogenetic and phylogenetic void. If I am looking at the whole syndrome in the right way it would be right to use a more comprehensive term.

When one sees a straightforward anterior open bite with no anteroposterior error in early years one is confident that, in the absence of a high Frankfurt–mandibular-plane angle and in the absence of a persisting lisp, the condition will gradually improve without treatment. The size of the tongue appears to be too large in relation to the oral cavity and to be hindering occlusal rise of the incisors. It is particularly noticeable at the time of eruption of the permanent incisors, when they need to travel far if they are to span the increasing intermaxillary gap. The tongue, like the eyes and brain, is relatively large in the early years, and with age becomes reduced in proportion. It is not unreasonable to suppose that there is sometimes a lack of precise timing in proportional reduction of tongue size, and on the face of it one hardly needs to go further than to regard the simple anterior open bite as due to a temporary maladjustment in tongue morphology. The maladjustment can be superimposed upon any variety of unwanted behaviour in which the tongue shares, and can aggravate the adverse moulding effects of that behaviour in early years. In the absence of a temporary maladjustment, the normal diminution in the proportions of the tongue reduces the contribution that it can make towards those adverse effects. It is comforting to remember that age can take some of the sting out of adverse behaviour.

The gradual uprighting of normally related upper and lower permanent incisors is the natural tendency during the period of growth. It helps in turning the so-called convex profile of the lower third of a child's face into the straighter profile of an adult. This, I think, is a further indication of the continued reduction in tongue proportions. The alternative which has been suggested is that the continuous muscular band external to the arches ceases growing before skeletal growth has finished. The suggestion seems less feasible.

Björk (1947), in *The Face in Profile*, demonstrated that the angle between the long axes of the upper and lower incisors showed an average increase of some 9° between the ages of 12 and 21–22 years (*Fig.* 3). Taking the occlusal plane as a base line he showed how

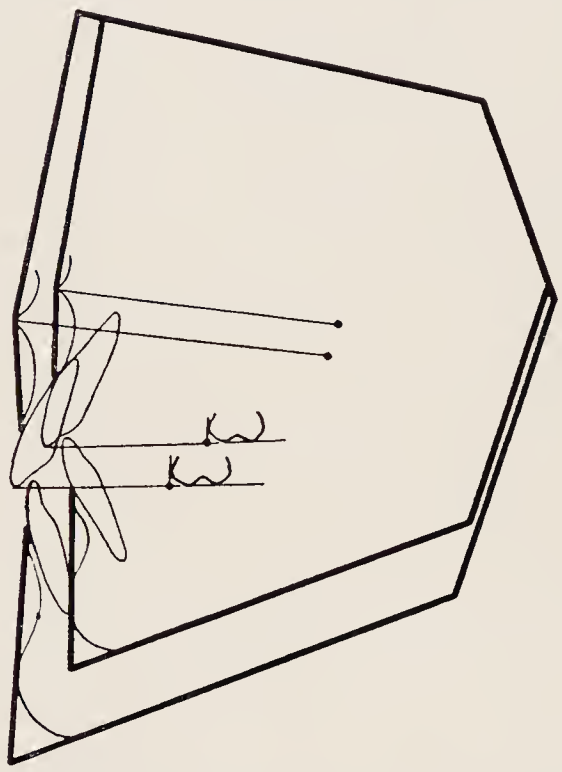

*Fig.* 3.—Superimposed tracings of case at 12 years and 21 years of age. (*From "The Face in Profile", by kind permission of Professor A. Björk.*)

much the upper and lower incisors contributed respectively to this change. In round figures, the upper incisors become more upright by 6° and the lower incisors by 3°. It is useful to recall this general tendency when one is confronted with a dentition with just enough bimaxillary proclination for parents to have raised a query about orthodontic treatment.

If one analyses the change in incisor angulation using the *mandibular* plane as a base line, it can be seen that the lower incisor angle changes more than the upper. The change of the lower incisors accounts for most of the increase of 9° in the angle between upper and lower incisors. This finding strengthens our caution in carrying out treatment aimed at proclining lower incisors, even when we think that the soft tissue environment is satisfactory. Lower incisors are sometimes subjected, incidentally, to forward pressure, while other aims are being pursued, but wily clinicians know that the avowed intention should not be that the incisors should stay forward.

Björk's work brings out a further interesting thought, which has a bearing, I think, on previous remarks about the waning effects of an adverse soft tissue environment. He found that those children with an overjet at 12 years had a reduced overjet at 21–22 years, which was produced by the lower incisors going against the general trend and becoming more proclined. This finding, by the way, cannot be a justification for proclining the lower incisors as part of treatment to correct an overjet, for, statistically, they are proclined only in the presence of an overjet.

I would like to turn to some points dealing primarily with hard tissues. I wonder how vital it is for treatment planning to make a prior assessment of the dental base relationship in the anteroposterior plane? I am not doubting the necessity of being aware of the Frankfurt–mandibular-plane angle and the implications attached to extremes of angulation. I am thinking only of anteroposterior relationship of the dental bases. It would help undergraduates enormously if it could be sidetracked and it would also make for easier communication between the initiated and the mass of general practitioners who do not know what it is all about, and who will not be replaced under 20–30 years. As far as the hard tissues are concerned, plans for treatment must be based on the occlusal or morsel perimeter of the lower arch—not the arch at gum level or apical level. I have so often heard a candidate in the final examination put up a muddle-headed show at assessing clinically the dental base relationship and then proceed to describe a perfectly sensible line of treatment which, did he but declare it, was based on the lower morsel arch.

To use the lower morsel arch in this way does not entail being ignorant of the factors which determine the degree of overbite, for it is the anteroposterior relationship of the lower incisor edges to the upper incisors that counts. The apical position of the lower incisors can vary in the anteroposterior plane while a given point of contact of their incisal edges is maintained with the upper incisors. It is maintained by variations in the slope of the lower incisors. We are already aware of the

several conditions governing lower incisor inclinations.

Again, the acceptance of the lower morsel arch as a basis does not prevent easy assessment of the final slope of the upper incisors after, for instance, correcting a Class II, division 1 dentition. All the information required is there on the surface for one to examine. One can weigh up the desirability of simple tilting movement for incisor retraction or of bodily movement.

The use of the lower morsel arch as a basis for treatment planning will not, however, direct treatment towards those alleged realms of pulchritude which result from having lower incisors at an angle of 62° to the Frankfurt plane, and contriving treatment of the upper arch to comply with this lower requirement. Although this treatment is popular in the United States, we do not seek to alter the profile to this extent here. It assumes that a considerable disturbance of the whole dentition is justifiable and that we all think alike about beauty. One tends, I find, to get tired of green peas now that they can be obtained out of a tin all the year round.

With the lower morsel arch in mind, either as it stares the undergraduate in the face before treatment begins, or as he envisages its size and its ultimate position in the incisor region after any desirable reduction in the number of lower teeth has been made, he can be made to appreciate, without great difficulty, what conditions need to be satisfied to arrange upper teeth around the lower morsel perimeter as closely and as smoothly as is feasible with the probability of stability.

The assessment of the dental base relationship with X-ray or by clinical examination is, I find, very prone to encourage the unwary to regard orthodontics as a mathematical discipline with some technique thrown in. It deflects thoughts from the one feature of an individual's dentition, namely the lower morsel arch, around which treatment plans for that individual have to be considered (*Fig.* 4).

The morsel arch still remains a working basis whether the patient is Anglo-Saxon, Middle European, or of any other type.

If there is a thread running through the first part of this paper it may perhaps be seen as a plea for some simplification of a subject which nowadays risks being regarded as an

*Fig.* 4.—The lower "morsel" arch. Case showing good alinement with six lower incisors present.

exclusive speciality. The curriculum of undergraduate schools makes for early division of instruction. The machinery at work to produce candidates for orthodontic consultant appointments unwittingly endorses the exclusiveness. The American example subtly persuades that orthodontists are a separate breed. I cannot believe that the subject should be so discrete. Orthodontics should surely remain a part of the work of the general practitioner, and his handling of orthodontic problems will become more valuable as his experience of general practice lengthens, providing he has not been frightened off the subject in his early years.

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# SOME PROBLEMS FOR CONSIDERATION. II

By **R. E. RIX**, F.D.S. R.C.S., M.R.C.S., L.R.C.P.

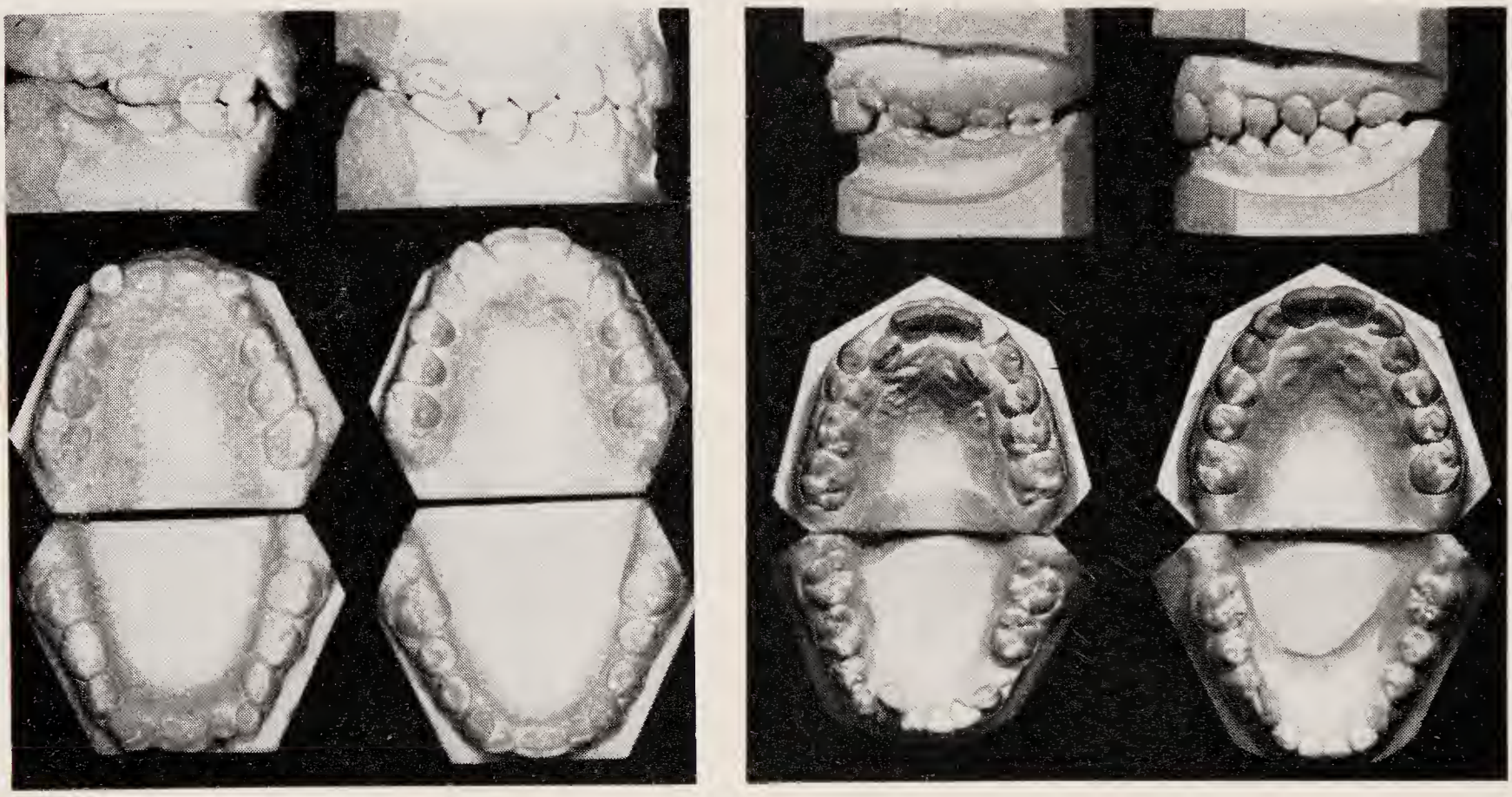
## SOME PRACTICAL PROBLEMS

TURNING to a different topic, I think the schools could, with advantage, spend more time in dealing with the problems and disappointments which frequently arise from the poor lasting quality of the first permanent molar teeth. Every few years letters are seen in the *British Dental Journal* from established practitioners either advocating the extraction of all four first permanent molars or stressing that no pains should be spared in patching and preserving them. Practitioners are concerned about a very real problem.

Parfitt (1956) found that 90 per cent of all first permanent molars in London schoolchildren of 9 to 10 years of age had become carious. Wilkinson (1942) is a ready advocate of the removal of all four, providing certain conditions are satisfied, but when he addressed this Society his paper was not accompanied by very adequate illustrations of results. Begg (1956), in more recent times, has been quite ready to extract these teeth, but the subsequent fixed apparatus technique which he uses is too complicated for widespread appeal in this country.

How best to turn the extractions to orthodontic advantage would provide material for a whole lecture. One point of particular interest is the effect, if any, upon the degree of overbite. If the effect is negligible in Class I occlusions the effect will be as negligible in Class II occlusions after treatment has corrected the arch relationship in the antero-posterior plane.

Lundström (1958), in his Northcroft Lecture, said there was no change in the degree of overbite following these extractions, his statement being supported by a paper by Lysell (1957) in which 18 cases were followed up after the extractions were performed between the ages of 7 to 10 years. I have records of 10 cases of



A B

*Fig.* 5.—A, Case treated by extraction of $\frac{6|6}{6|6}$. No appliances. Models at $8\frac{1}{2}$ years and 12 years. B, Case treated by extraction of $\frac{6|6}{6|6}$ with appliance to guide $\underline{2|2}$ into place. Models at $8\frac{1}{2}$ years and 15 years.

Being the second part of the Fourteenth Northcroft Memorial Lecture given on November 14, 1960.

Class I crowding where all four first permanent molars were extracted early. The average change in overbite was 0·29 mm. increase. Serial profile X-rays would have been useful to demonstrate the effect on the whole dentition, but I have none. One would want to have started the X-rays well before the extractions. I hope some younger man will produce a piece of work on these lines. Broadbent (1943) wrote that the congenital absence of teeth led to a failure of the dental arches and the supporting alveolar bone to approach their normal size and relative position to their maxillary and mandibular bases. By depriving a crowded dentition of the presence of the four 6's quite early, one certainly gets no clinical impression that the upper and lower incisors become markedly retroclined, having lost the buttressing effect of the crowns of all cheek teeth in contact (*Fig.* 5 A, B). One would expect the overbite to deepen considerably if the incisors just fold back.

The conditions necessary to confer some benefit to the dentition without the use of appliances (*Fig.* 5 A) and without leaving much on the debit side following the loss of the four first molars are:—

1. That the extractions should be done between 8 and 10 years of age.
2. That the incisor crowding should be only slight.
3. That there should not be any rotation of the incisors.
4. That the molar relationship should be Class I.
5. That the molars should not, prior to their extraction, have migrated from their rightful place due to early loss of deciduous molars.
6. That X-rays of successional teeth show no abnormality, with special reference to the developmental position of the lower 5's and upper 3's.
7. That the overjet should be acceptable.
8. That the overbite should not be hovering at the point where the gum margins, either upper or lower, could be traumatized.

Obviously many dentitions do not possess these requirements. There are many with arches showing *more* than slight incisor crowding. In these, a serial extraction technique can be employed, providing the E's look like lasting their full term. The four deciduous canines can be extracted at approximately 8 years of age and the incisors left free to drift. Natural improvement is usually sufficient to withhold appliances. The first

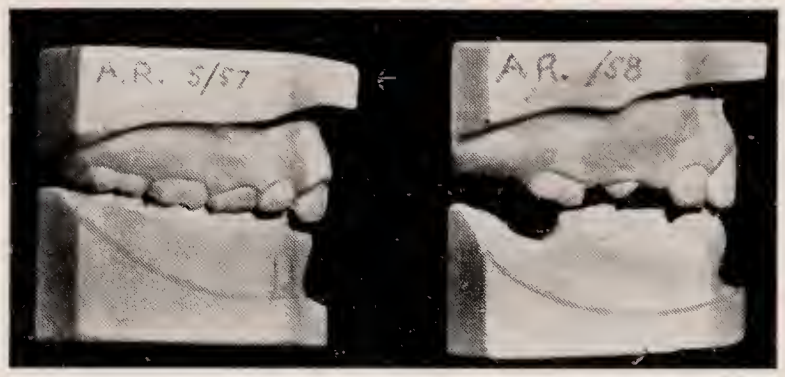



*Fig.* 6.—Case showing mechanical distal movement of $\underline{E|E}$ to enable $\underline{4|4}$ to erupt distally and prevent forward movement of $\underline{7|7}$ following extraction of $\frac{6|6}{6|6}$. $\frac{C|C}{C|C}$ were extracted still earlier to allow natural correction of incisors.

molars can be extracted at $8\frac{1}{2}$ to 9 years of age. Extractions can be staggered, taking $\underline{6|6}$ a few months before $\overline{6|6}$. There is then the real risk of the upper second molars erupting forward enough to deprive $\underline{3|3}$ of sufficient room to drift into good alinement. It is after $\underline{6|6}$ have gone that an appliance is essential. An upper plate can be used with a screw at each side to move $\underline{E|E}$ well distally There is no need to move the D's distally too. Following the loss of $\underline{6|6}$, unerupted premolars tend to move distally in face of anterior crowding. A real obstacle to the eruption of $\underline{4|4}$ in a more distal position is the continued presence of $\underline{E|E}$. Move the E's distally and the 4's erupt well distally (*Fig.* 6). Another virtue of moving $\underline{E|E}$ distally is that they will prevent $\underline{7|7}$ erupting too far forward. $\underline{7|7}$ erupt quite early following the loss of 6's, and in the cases I have treated $\underline{E|E}$ have not been shed before the eruption of $\underline{7|7}$.

The upper plate should carry a small anterior incline to reinforce the distal thrust on $\underline{E|E}$ and the screws should be turned weekly, but on different days. A labial bow and boxed-in palatal springs can be added if rotations are present. The bow can stretch from mesial $\underline{D|}$ to mesial $\underline{|D}$.

In the lower jaw it is not always necessary to move the E's distally in a similar way. Lower 7's are slower to drift forward than

their opposite numbers, and there can still be time for premolars to drift distally enough for the more anterior teeth to move into better alinement naturally. Nevertheless, if the lower

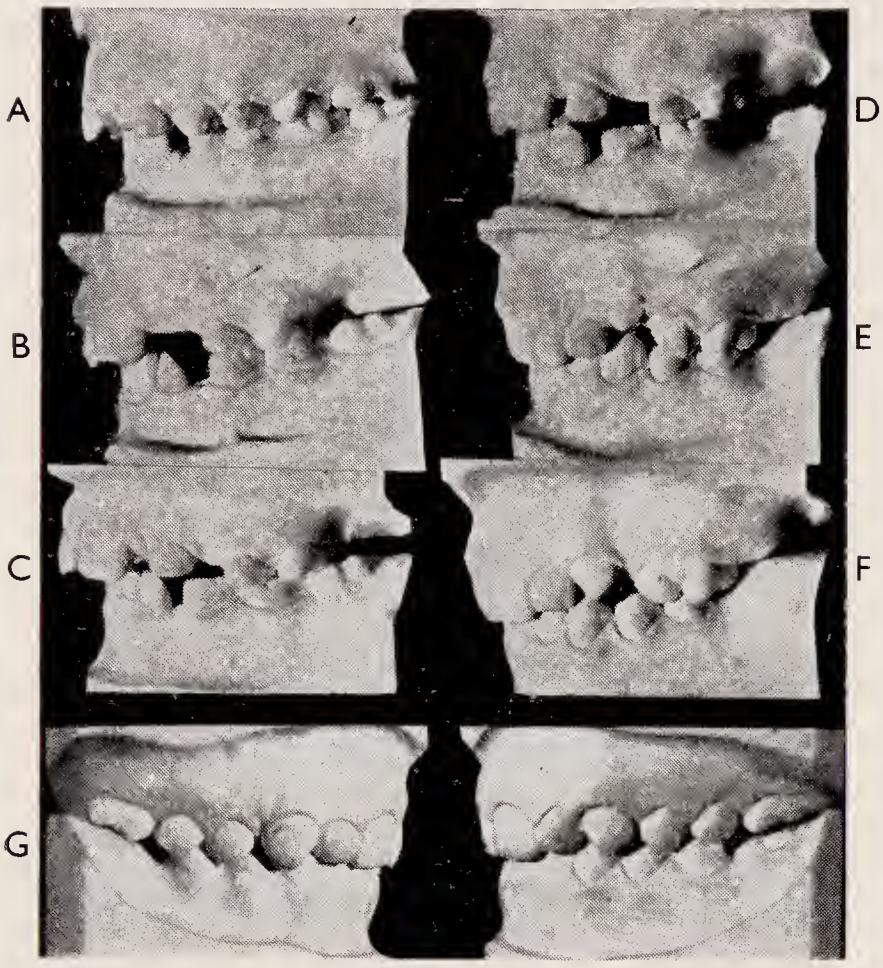



*Fig.* 7.—Stages in case treated by extraction of $\frac{C|C}{C|C}$ and $\frac{6|6}{6|6}$. A, June, 1955, Models at commencement of treatment immediately prior to extraction of $\underline{C|C}$. B, June, 1956, Extraction of $\frac{6|6}{C|C}$. C, January, 1957, $\underline{ED|DE}$ moved distally. D, August, 1957. Andresen appliance used to remove overjet as anchorage had been disturbed. $\overline{6|6}$ extracted. E. April, 1959, Eruption of premolars into Class I occlusion. F, September, 1959, Eruption of premolars into Class I occlusion. G, September, 1960, Final models showing some slight residual incisor irregularity which could have been corrected had treatment been permitted to continue.

of a Class I relation of the 6's, introduce further problems.

There is the wretched dilemma in Class II cases of delaying, if possible, the extraction of the 6's until the 7's erupt, so that the upper 7's can be prevented from moving forward while premolars and canines are moved distally. The delay leads to excessive tilting of lower 7's and there is sometimes the doubt that neglected 6's can be kept comfortable until the 7's erupt. There is a way out of the difficulty, providing some simple measures are

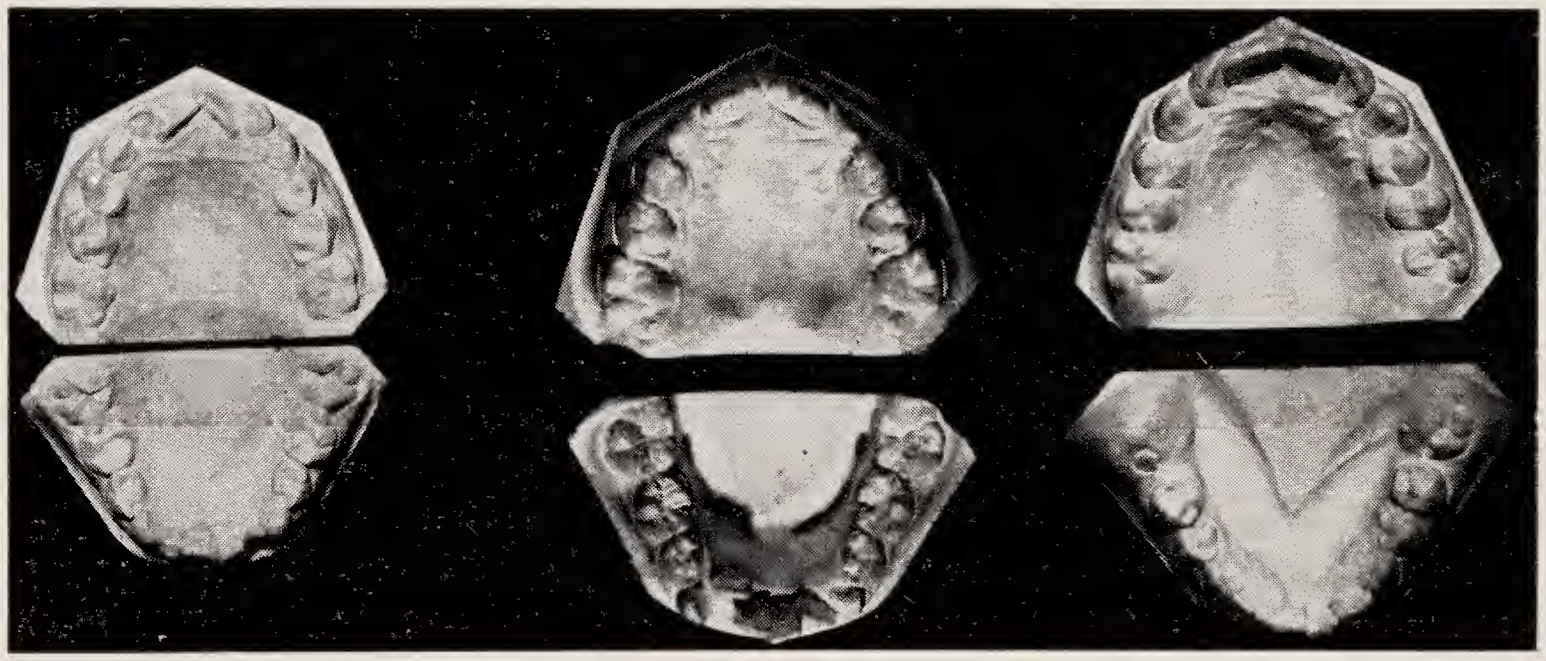



*Fig.* 8.—Occlusal views of case shown in *Fig.* 7. A, Before treatment. B, After extraction of $\underline{C|C}$ and before $\underline{6|6}$ had been extracted and an appliance used. C, At stage when $\frac{7|7}{7|7}$ were erupting.

lateral incisors, in improving their position earlier, have encroached considerably upon the space left by the extraction of $\overline{C|C}$ then it is advisable that the $\overline{E|E}$ should be moved distally.

Dentitions with all the conditions reasonably favourable for the loss of the four 6's, with the exception of the important condition taken with precision and understanding. Both Angle's Class II, divisions 1 and 2 can be dealt with, though I would not expect complete success with those Class II, division 1 cases with a marked anterior open bite with incompetent lips in association with the visceral type of swallowing behaviour and with a lisp in speech. But, of course, one would make a

guarded prognosis in these eases whatever plan was followed. I have a ease here whieh illustrates the line of thought required, and brings out mistakes that can be made (*Figs.* 7, 8). The 6's were extraeted a little earlier

*Fig.* 9.—Case treated by extraction of $\underline{6|6}$ and Andresen monobloe. First model at 8 years 6 months. Bloe fitted at 8 years 10 months. $\underline{6|6}$ extraeted at 9 years 2 months. Seeond model at 9 years 4 months.

than was probably needed, but by taking very simple measures, Nature was helped to help herself, and the amount of active tooth movement required was redueed. The ease is not shown as a high finished speeimen typieal of the perfeetion usually shown in print. For perfeetion, a little more applianee therapy would have been neeessary, but the child's parent, at all times anxious to avoid applianees, was content.

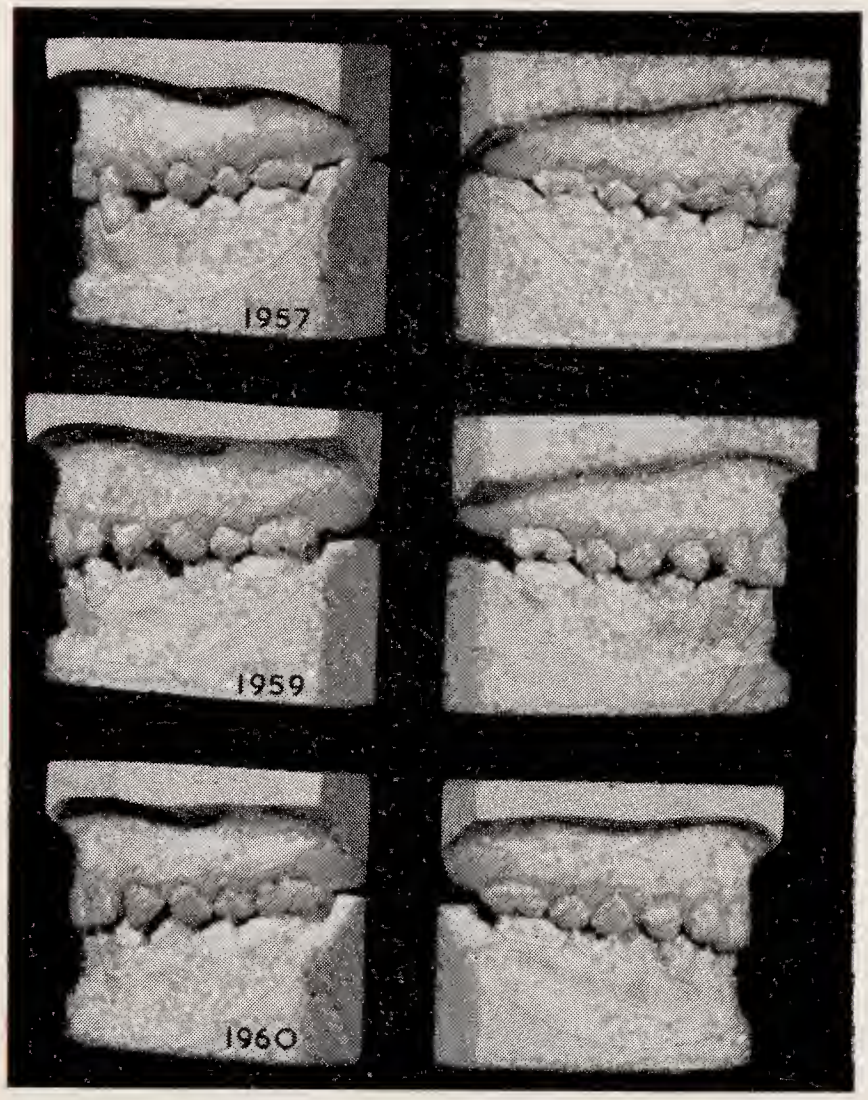
I judged the ease to be essentially a Class II, division 2 type with eonsiderable erowding. The soft-tissue behaviour was keeping the upper ineisors elosely related to the lower morsel areh in the anteroposterior plane, though laek of room was preventing the typieal Class II, division 2 ineisor pieture eoming into being. Treatment given was the serial extraetion of the four C's and the four 6's and the moving baek of upper deeiduous molars with removable applianees. Starting at the age of 6 years 3 months the extraetions were staggered thus (*Figs.* 7, 8): (1) $\underline{C|C}$; (2) $\frac{6|6}{C|C}$; (3) $\overline{6|6}$.

No applianee was used until $\underline{6|6}$ and $\overline{C|C}$ were extraeted, by whieh time (7 months) the rotation of $\underline{1|1}$ had beeome correet. $\underline{E|E}$ were then moved distally, and the movement earried further than previously described for Class I cases. ($\underline{D|D}$ were also moved distally at the same time and anehorage was disturbed enough to produee an overjet.) Knowing what I know now, there was no need to move $\underline{D|D}$ nor need I have been anxious about the overjet, for it would have eorreeted itself subsequently.

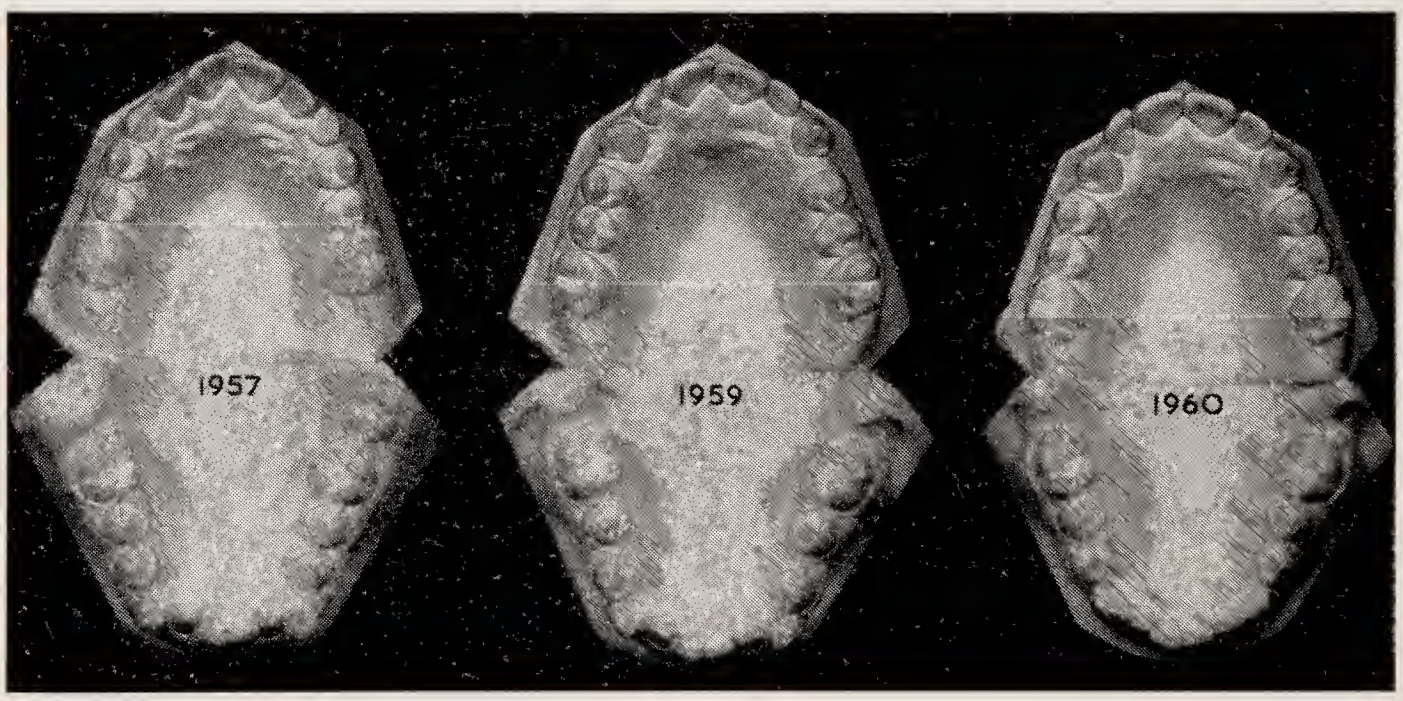
*Fig.* 10.—Showing possibilities of apieal movement of molars with simple fixed appliance as illustrated by X-ray of $\overline{6|}$ in a ease where a simple lingual arch and Friel spring was misapplied.

*Fig.* 11.—X-ray to show good position of $\overline{|8}$ after extraetion of $\overline{|7}$ immediately on eruption.

As it was, I used an Andresen appliance and the overjet disappeared in a few weeks. The appliance, incidentally, served to move $\underline{E|E}$ still more distally. No separate lower appliance was used. $\overline{6|6}$ were extracted one year after $\underline{6|6}$.




A




B

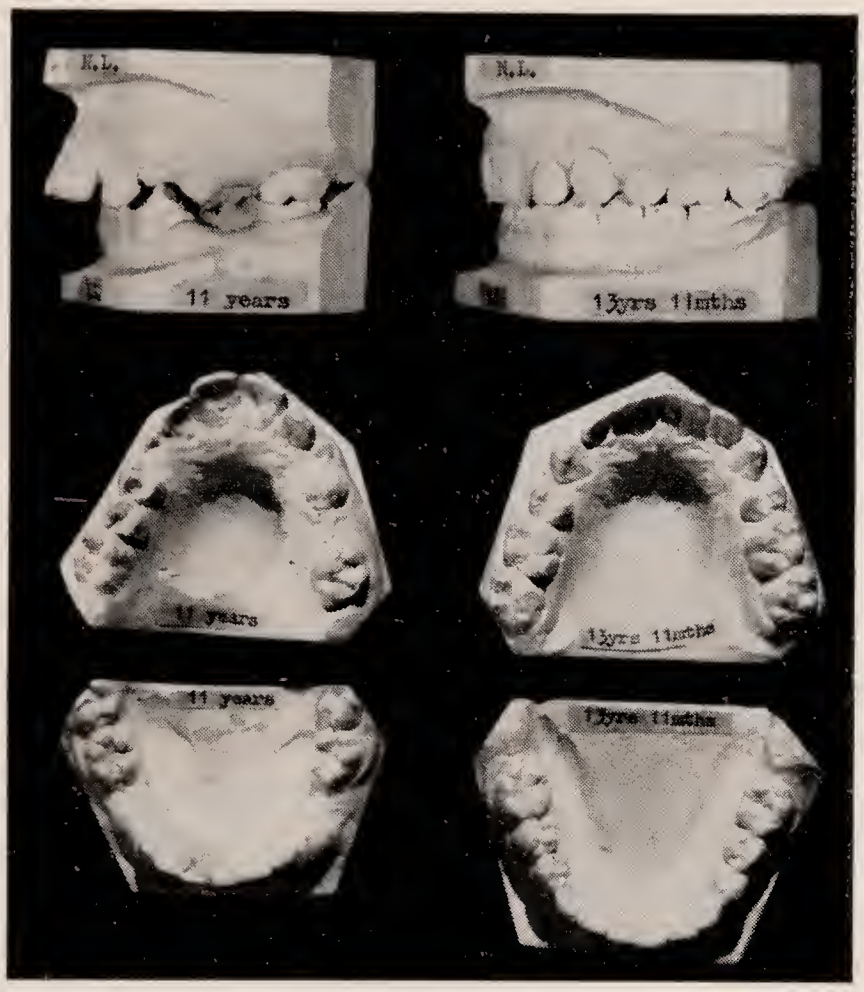
*Fig.* 12.—A, B, Ideal case treated by extraction of $\frac{7|7}{7|7}$.

In cases of Class II, division 1 some form of intermaxillary traction is essential. I apply it via an Andresen monobloc. I usually have little difficulty in settling it in comfortably and readily with a loosish bow. When the distal border of the upper E's is distal to the distal border of the lower E's the $\overline{6|6}$ are extracted. and again the bloc is trimmed away locally.

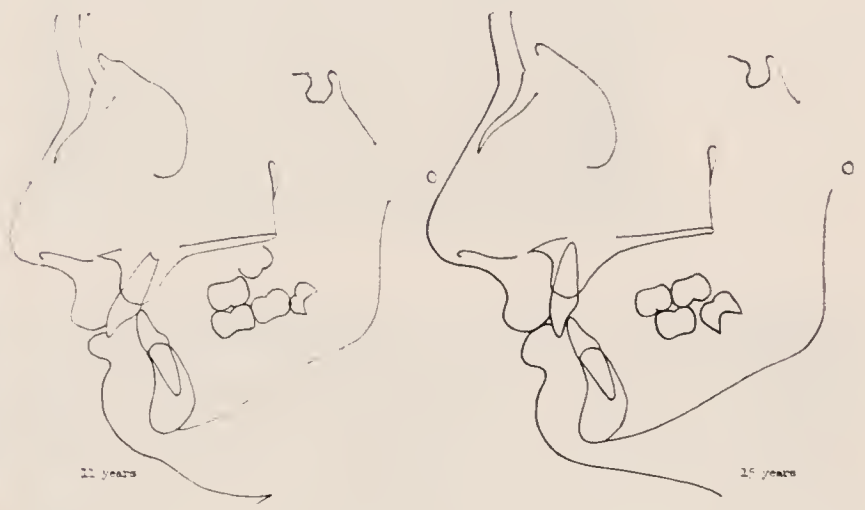
there is the added advantage that with suitable trimming the lower deciduous molars are not encouraged forwards. I have the bloc at work in the mouth for a month or so before extractions are done to ensure that everything is comfortable and acceptable to the patient and that I am satisfied that it can do its job. A bloc is made more acceptable if a half-moon-shaped window is cut out anteriorly, with the base line just above the lower incisal edges. Orthodox Class II trimming is done on the upper half of the bloc. On the lower half the reverse of orthodox trimming is carried out. The bloc is trimmed out of contact with the *distal* contours of the lower deciduous molars. The upper first permanent molars are then extracted and the bloc trimmed back locally. Resistance to movement of upper cheek teeth is so completely reduced that improvement of cheek teeth relationship is quite rapid.

One should be careful not to have a tight labial bow. It should barely touch the incisors. A tight bow concentrates the intermaxillary thrust on to the upper incisors. A loose bow concentrates a distal thrust on to upper deciduous molars, and it is they, and especially the E's, that one wants to move distally. The upper incisors move back none the less

The bloc is kept in operation until one is satisfied that the first premolars are going to erupt into a Class I relation, not forgetting that the lower 4's are going to drift distally. I usually step up the distal thrust on the upper E's by either adding a thin layer of cold cure




A




B

*Fig.* 13.—A, Class II, division 1 malocclusion treated by extraction of $\underline{4|4}$ and $\overline{7|7}$ at 11 years. No lower appliance was used. B, Tracings at 11 years and 15 years of the same case showing good eruptive position of cheek teeth and stable incisor relationship. Note particularly early and favourable eruption of 8's.

acrylic at intervals to the bloc where it contacts the mesio-lingual surface of the E's or by adding springs to the bloc. Unless springs are positioned and used with precision they are worse than useless.

The case shown in *Fig.* 9 shows a response of a Class II, division I occlusion to a monobloc which Korkhaus claims to see frequently. This is the only one I have seen. I tried without success to get the patient to bring his deciduous cheek teeth into occlusion.

I should explain that the bloc was trimmed so that there was no hindrance to occlusal rise of the cheek teeth. Korkhaus maintains that the phenomenon is proof that the bloc induces the mandible to move forward or to grow more forward. A more likely explanation, I think, is that the re-adjustments in occlusal level, which ordinarily accompany a change in arch relationship, are taking place somewhat slowly in the deciduous cheek teeth. Deciduous molars not infrequently fail to maintain adequate occlusal rise.

Some mesial tilt of lower 7's can always be seen in X-rays following the extraction of lower 6's, though clinically it is often acceptable. Uprighting requires fixed apparatus and *Fig.* 10 gives a clue to what apical movement can be obtained by using a relatively simple (though often misapplied) mechanical principle. The figure shows how a lingual bow, pressing downwards and forwards on the lower incisors, serves to gather forward the roots of the anchor teeth (the condition was bilateral). The incisors are temporarily proclined into unstable positions. In the example, the anchor teeth were lower 6's and the forlorn aim was permanent proclination of lower incisors.

Another aspect of treatment worthy of more exploration is the extraction of 7's where there is insufficient room in the arches for good alinement. Assuming that the developing 8's are not diminutive, that their inclination is normal, and that the quality of the 6's is satisfactory, there are several conditions where the extraction of 7's can simplify treatment. Just as the early loss of 6's often permits 7's to assume acceptable positions, so the extraction of 7's *immediately on eruption* gives the 8's an equally good chance of gaining an acceptable position (*Fig.* 11). Longer following up of past extraction treatments of this type should enable one to predict with precision the cases

which will respond most satisfactorily as far as the final position of 8's is concerned. Malocclusions, where these extractions can produce a better result with simpler treatment, are found among those with a normal or a Class II relationship of the cheek teeth with only slight crowding in the lower arch at 12 years of age, particularly when there are general tendencies towards retroclination of incisors and deep overbite (*Fig.* 12 A, B). Problems of residual spacing are avoided. The extraction of $\overline{7|7}$ and two upper premolars in slightly crowded arches in Class II, division 1 relation can also be a useful combination relieving one of the necessity of employing intermaxillary traction which would otherwise be required if two lower premolars were extracted instead (*Fig.* 13). Again, where lower 6 has migrated mesially, following the early loss of deciduous molars, the extraction of lower 7 will allow an unerupted and temporarily impacted lower 5 to push lower 6 distally and erupt normally, providing its initial position in the X-rays is vertical (*Fig.* 14). This way of disimpacting a

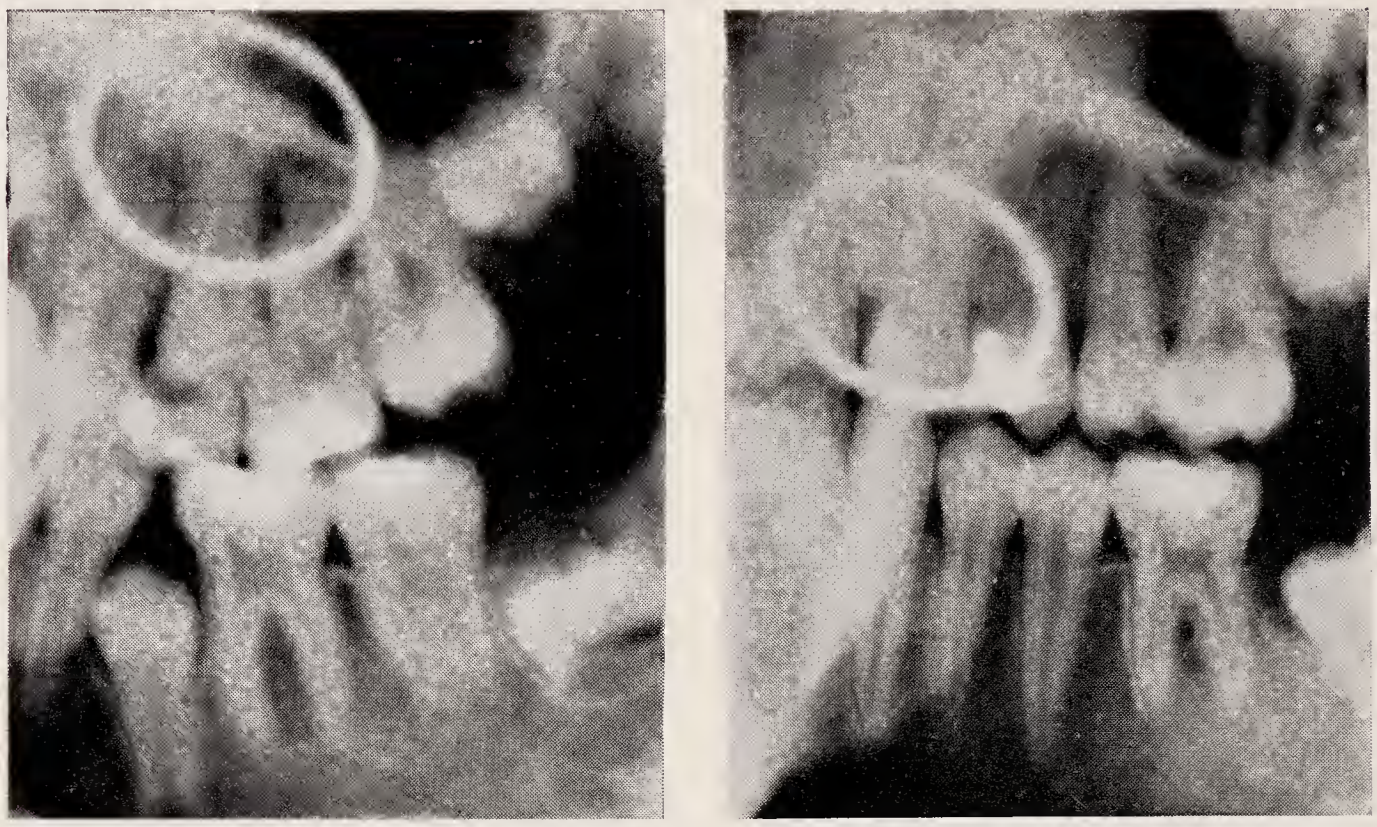


*Fig.* 14.—X-ray series showing impacted $\overline{|5}$ gaining the lower arch after extraction of $\overline{|7}$.

*Fig.* 15.—Case showing extraction of $\frac{7|7}{7|7}$ and distal movement of upper buccal segments. No lower appliances. Class II occlusion.

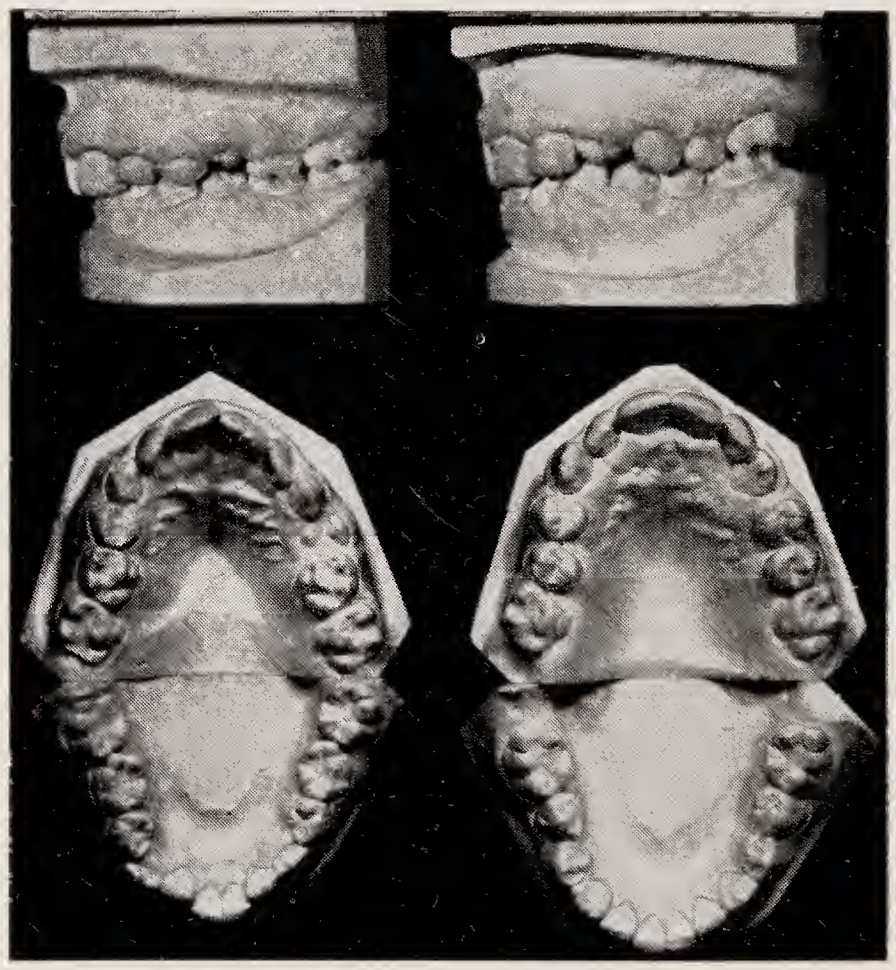


*Fig.* 16.—Case showing extraction of $\frac{7|7}{7|7}$ and distal movement of upper buccal segments. No lower appliances. $\underline{|3}$ not fully erupted as it was exposed surgically. Mild Class II.

lower 5 can, however, be disappointing and lead to anterior crowding if the distal movement of lower 6 is limited by the over-eruption of upper 7. It can happen where the relationship of the cheek teeth is Class II, but it can be avoided by moving lower 6 distally with an appliance. Alternatively, if an upper appliance is in use as in *Figs.* 15, 16 it can be modified to prevent over-eruption of $\underline{7|7}$. These two cases were Class II, div. 2 type, treated with upper removable appliances only, to move cheek teeth distally and to aline anteriors. An anterior incline was always incorporated. The incline caused a degree of over-proclination of the lower incisors which subsequently relapsed without, however, a return of malalinement.

In conclusion, I hope you can consider this paper in the light of the chronic shortage of dental manpower where it is not helpful for complexity of treatment to increase in order (to misquote Parkinson) to keep pace with the elaboration of apparatus.

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## *DISCUSSION*

*Mr. J. H. Hovell* said the President had already remarked upon the attendance at the Meeting, which undoubtedly was a sign of the esteem and, indeed, the very real affection which every Member of the Society felt for Mr. Rix. (*Acclamation.*)

The first important point raised was that of the teaching of the basic sciences and pre-clinical subjects. It would seem that no one could fail to agree with Mr. Rix on the basic broad principles underlying his views. He would take issue with Mr. Rix when he said that what was considered to be an adequate background for general dentistry was not an adequate background for orthodontics. Surely the truth of the matter was that the background for general dentistry was inadequate, leading to a poor understanding of problems arising in branches other than orthodontics, and should be raised.

Was it not necessary first, however, to teach the teachers? It would be interesting to hear Mr. Rix's views on a complete integration of the second M.B. and second B.D.S. courses.

In his view Mr. Rix rightly laid stress on the part played by the general practitioner in carrying out orthodontic treatment. How about the consultant? Friel, at the American Association of Orthodontics' Meeting in Washington, had stated that, in his view, the orthodontist should commence his specialized training immediately after, if not before qualification, and should have no contact with general dentistry.

His own view was diametrically opposed to that, even to the extent that he believed the institution of pure orthodontic consultant posts to be a retrograde step—one of the steps which was divorcing dentistry from medicine and reducing it from a science whose most important aspect was diagnosis and treatment planning to something little better than a skilled craft.

In his opinion, before turning to orthodontics a man should spend at least two years in general dentistry and at least two years in a general dental trainee specialist post. His pure orthodontic training should then commence at the senior registrar level.

Where did Mr. Rix stand in that matter?

His own views on soft-tissue patterning coincided very much with those of Mr. Rix. He tended, however, to divide atypical patterns of activity into two main types —innate and habit. The vast majority of those were habit activities, due to and not the cause of malocclusion. and corrected themselves when the malocclusion itself was corrected. They did not in any way hinder successful treatment. He had very grave doubts as to whether the tooth apart swallow was ever *per se* innate. He thought it was rather a swallow commencing from a postured position of the mandible with the cheek teeth apart. It would be interesting to hear Mr. Rix's views on that.

He absolutely agreed with Mr. Rix's remarks on incompetent lips. He had been one of the people who started that red herring and unfortunately that paper of his was still read! He believed that they were of importance only when owing to other aetiological factors. for example skeletal or habit, such as thumb-sucking. the development of a normal overjet or a Class II. division 1 incisor relationship was in the balance. In such cases they might be the determining factor, but not otherwise. Although he considered the effect of normal soft-tissue patterning paramount in the production of normal occlusion and dental relationships, he was tending to discount more and more the effects of abnormal soft-tissue patterning in the production of malocclusion and to consider the skeletal pattern and tooth–tissue relationship to be far more important.

Mr. Rix had given as a basic principle the acceptance of the lower morsel arch in treatment planning. He had not used those exact words himself, but rather the position of the lower labial segment, having due regard to the expected development changes which Mr. Rix pointed out. He thought Mr. Rix's expression was better as it also brought in the necessity of maintaining buccal segments in soft-tissue balance.

He had been pleased to hear Mr. Rix's remarks regarding collapse of the arches after extraction. He did not believe that arches collapsed, but merely found the stable position with soft-tissue balance, when they had previously been buttressed out by interproximal contents, and that movement was in fact a small one. One saw many intact arches which would undoubtedly have been described as "collapsed" had teeth been removed. Had he understood Mr. Rix rightly when he took that to be his view also?

*Miss L. M. Clinch* said that as a clinician she had picked up some good tips, but probably Mr. Rix would be aware that she was ready to do battle with him on some of the points which he had made. He must have specialized a long time ago. and yet he was now advocating. as

far as she could make out, that all orthodontic treatment should be done by general practitioners. She did not think that would be a forward step and she felt quite sure that many of the general practitioners would not wish to spend so much of their time doing orthodontics. She knew of nobody who advocated that orthodontics should be taken out of the undergraduate course. As a matter of fact, she believed that the development of the dentition and of occlusion was the basis of dentistry, and probably, as things were at the present time, the orthodontic lectures were the most valuable that the undergraduate got in many schools, but she thought that complicated treatment should certainly not be taught as an undergraduate subject. There just was not time.

With regard to the term "incompetent", perhaps it was a weakness of hers but she thought it was a frightfully bad term to use. It was most misleading. What were they incompetent to do? One could masticate with them, one could talk with them; they were competent to do those two things, which were probably the two most important functions of the mouth. She thought it was misleading to graduates and it must be extremely misleading to undergraduates. It was one of the worst terms which had got into orthodontic literature.

Mr. Rix had said that treatment was often based on the morsel surfaces of the lower teeth. Would it be a good thing sometimes to base it on the appearance of the child? That seemed to her to be the most helpful thing to do, and personally she would not diagnose a case from a pair of models.

Finally, what damage did an increase in overbite cause?

*Mr. H. G. Watkin*: In extracting the first permanent molars Mr. Rix mentioned that the uppers should be extracted first in Class II cases. That was most essential. In taking out the 6's one must take uppers before the lowers in Class II cases, then the lower molars would keep the pre-molars forward and the upper pre-molars would drift into normal position and, in many cases, into normal relationship.

He had been very interested to hear Mr. Rix mention about keeping the 7's back, because it was surprising how soon the upper 7's came forward before one got the 5's back.

*Mr. D. G. Timms* said he thought that Mr. Rix had rather over-simplified the atypical swallow. He always got the impression from Mr. Rix that in an atypical swallow the cheek teeth were apart. He had carried out a very large number of examinations on atypical swallows and found that was not always so, and very often the teeth were together in an atypical swallow and the tongue thrust was accompanied by anterior open bite.

There was also the question of the extrusion of the tongue. Sometimes one saw an extrusion of the tongue, but it was surprising the degree of the intrusion of the lower lip that had been recorded. Somehow it was sucked in. All these were seen very clearly on cinéradiographic examination—far more so than the normal clinical examination permitted. It was quite important and he hoped that they would be able to publish some of those facts later when they had examined some more cases.

*Mr. T. Jason Wood*: There were one or two points which he wished to make. Firstly, having had something to do with students over about twenty odd years he had found a very noticeable degree of increase in intelligence and interest with regard to orthodontics, and he thought it was a great pity that the modern tendency was not to allow the students to do anything themselves. He thought that every student should move one tooth over the bite once! (*Laughter.*)

He would not use the term "incompetent lips" because he preferred to use the term "the open lip posture"—it was obvious from the number of children that one saw who had this, that it compared to the number of adults. One had only got to look round a bus or a football crowd in order to see that, and a tremendous lot of it should be disregarded. It was what they called up in Yorkshire a "gawp" and even perfectly normal children had it; one saw them standing round watching a hole in the road being made and standing with their mouths open. He believed that a tremendous lot of it was just immaturity and that they grew out of it.

*Professor C. F. Ballard* said he thought he ought to stand on his feet because he believed he had detected a hint of criticism of postgraduate teaching! He wished to point out that in papers in the past he had said exactly the same things as Mr. Hovell, and he did not believe that what they had to teach at postgraduate level should be postgraduate teaching at all. He had also said that he did not think it was orthodontics; he thought it was fundamentally a basic teaching of all branches of dentistry, and he had been a little distressed that evening to hear Mr. Rix say that and then appear to retract some of it when he said that the student did not have to be able to assess dental base relationship. He did not think the orthodontic clinician necessarily had to be able to assess the dental base relationship, but he certainly thought the prosthetist had to, and they were teaching, he believed, the fundamentals which the prosthetist had to know and which should come early in the curriculum.

He also agreed with Mr. Hovell in that he did not think the orthodontic consultant was that primarily; he was a dental consultant first and his orthodontics were secondary to that. He entirely agreed with Mr. Hovell that it was essential not to specialize too soon.

*Mr. H. E. Wilson* agreed with what the President said regarding Mr. Rix's views on undergraduate teaching. He had mentioned how nice it would be to have in the pre-clinical years teachers with some dental background. and that was being brought about. When the undergraduates came into the clinical years, Growth and Development that had, or should have, been taught in their pre-clinical years was reversed and they started by repairing and making appliances for dentureless adults. The curriculum should be changed to follow the logical line, that is, the student ought to follow the child through to the adult during his clinical years. As far as possible. he should start by treating children and watching their growth and development through the clinical years and finally treating the adult.

He agreed, too, that there was a place in general practice for orthodontic treatment. It was not a completely specialized subject, as such. He agreed with Professor Ballard that they should have a general background and not be too specialized.

*Mr. W. J. Tulley* said that, from the previous speaker's remarks, did Mr. Wilson advocate that the undergraduate course should be ten or twelve years? Apart from understanding the problems of extracting the first molars the undergraduate should have a training in the observation of many cases to get an insight into the way teeth moved naturally following certain extractions in various circumstances. This was something which Mr. Rix had shown him to be all important.

*Mr. R. E. Rix*, replying to the discussion, thanked Mr. Hovell for his kind remarks about the paper. He had raised very many deep questions and he doubted whether Mr. Hovell had seriously thought that he would answer them all.

In the first place, Mr. Hovell had asked whether it was necessary first of all to teach the teachers. He believed that in the last eight or ten years the ground had shifted so much that teachers were often as confused as examiners, but he supposed that would get better in time. He entirely agreed that orthodontic teachers should have a longer period of training in general dental surgery than they had at the moment. They tended to look at the subject a little too narrowly.

With regard to advocating an entirely separate course; some years ago the Society had set up a Committee to look into orthodontic education and he, with Mr. Chapman, had signed the minority report which left the way open for a less specialized approach to the subject.

In his remarks with regard to swallowing, Mr. Hovell had doubted whether the tooth-apart swallow was ever *per se* innate. His own view was that people did change their mode of swallowing. It was a most interesting subject and he hoped that someone would take 1000 children and 1000 adults and see how they swallowed. He would be pretty certain that there would be fewer adults swallowing with their teeth apart than the children. It looked as though, if one started off with a tooth-apart swallow, it was not necessarily ingrained in one to such an extent that one could never forsake it, but whether it was a "habit", as Mr. Hovell had called it, he did not know if he could entirely agree.

Following on his remarks about incompetent lips Mr. Hovell had gone on to say that it was beginning to be his impression that the skeletal pattern and tissue relationship were getting more important in his mind than the soft-tissue environment of the arches. His own personal opinion was that they both played an equal part. Except in the extreme abnormalities in jaw relationships he did not think that one could disregard soft-tissue behaviour and imagine that it was playing only a minor part.

With regard to Mr. Hovell's remarks about collapse of the arches following extractions, he had an idea that with the *early* loss of, say, the 6's or the congenital absence of 5's the upper incisor apices were not so far forward as they otherwise would have been. It was not only that the crowns fall back because of the loss of buttressing effect, but again one wanted it to be proved with serial X-rays. He did not think that it applied equally in the lower arch. He would deal at leisure with the other points raised by Mr. Hovell.

Miss Clinch had not agreed that all orthodontic treatment should be carried out by the general practitioner. He quite agreed with that because some of the more difficult treatments would not be within his competence. However, he thought the general practitioner should be encouraged to do more useful orthodonties than he was doing at the moment.

Miss Clinch did not like the phrase "incompetent lips" and did not know quite what it meant. He thought that Professor Ballard had given an excellent definition of "incompetent lips", and others had done so several times in papers. As for the very word "incompetent" it was difficult to find an alternative: possibly one could say "inadequate" but he thought that "incompetent" really covered the situation pretty well and he thought everyone knew what was meant by it.

Miss Clinch had said that she would place great stress on the appearance of the patient when deciding upon treatment. Of course one did that, but one had to work within the limits of the individual and there were certain things one could do and certain things one could not do. Miss Clinch had also asked what damage was caused by an increase in overbite. He thought that a deep overbite mattered very little as long as the incisors were not on the point of traumatizing the gums. One of the Society's past Presidents had got a very deep overbite. He still had his full set of teeth—he had had dinner with him that evening.

With regard to the remarks made by Mr. Watkin one could, of course, use fixed appliances, as he had shown, with a lower labial bow.

With regard to Mr. Timms's remarks about atypical swallowing behaviour and the teeth usually together, it all depended upon what one called "atypical swallowing behaviour", he supposed. Some children did in fact occlude their teeth, and the tongue spread through an anterior gap—the endogenous tongue thrust which Professor Ballard had named. He did not quite like the term; although they usually occluded their teeth they did not necessarily invariably do so. From clinical observation he would have thought that a fair proportion of children did not in fact close their teeth during swallowing, and he would have thought that closure of teeth during swallowing was normal and beneficial. Perhaps Mr. Leighton, who had done a lot of work on oral behaviour with X-rays, could say something more about that.

Mr. Jason Wood had pointed out the encouragement that the student got by pushing one incisor over the bite, and he entirely agreed.

On the question of comparing the incidence of the open lip posture in children and in adults, he felt sure that as one grew older there was more and more a tendency for the closed lip posture. The early photographs in his own family album would show him as a "gawping" child to use Mr. Woods's phraseology, but he kept his lips closed now without effort. However, he thought that the real point to decide was whether there was a change in morphology which in the end allowed the lips to be closed without any contraction at all or whether—and he believed that this very frequently happened—the lips did stay closed, but with some slight subconscious contraction going on all the time.

Professor Ballard had thought that he had criticized postgraduate teaching, but he had not. However, he did think that there should be a longer period of general dental experience and he entirely agreed with Professor Ballard that orthodontic consultants were really general dental consultants and made a first-class contribution to dentistry.

Mr. Wilson had felt that children's dentistry should probably come early in the clinical course in the undergraduate schools. That was all right for the undergraduates, but it might not be all right for the children, and he had reservations about it.

# SOME FACTORS CONCERNED WITH THE REDUCTION OF EXCESSIVE INCISOR OVERBITE IN ANGLE'S CLASS II, DIVISION 2 TYPE OF MALOCCLUSION

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## INTRODUCTION

THE title of this paper is "Some Factors concerned with the Reduction of Excessive Incisor Overbite in Angle's Class II, division 2 Type of Malocclusion" with the emphasis on the word "some". Although an attempt has been made to cover several aspects of this subject there may be many other contributing factors as yet unknown.

Very rarely is any malformation or disease of any part of the body due entirely to one cause. It is more usual to find many influences which either work together to the same end, or are in opposition, and one cancels the effect of another to a varying degree. The result is a balance of these influences. Also, the body is not static, even in the adult state, and in childhood and adolescence is constantly changing. Factors present at one age may well be altered or absent at another, while other factors may have come into action which were not present earlier.

In treating malocclusions, at any given age it is impossible to predict a stable end-result without a thorough understanding of all the factors, viz.:—

1. Those present at the time of diagnosis.
2. Those arising as a result of, and during the course of, treatment.
3. Those arising during the period of treatment, but not connected with treatment, producing changes which would have occurred had there been no treatment at all.
4. Those that will be present at the end of treatment.

Some of these factors are favourable, some unfavourable, and some may well be favourable to one type of malocclusion but extremely unfavourable to another.

Interest in the factors involved in the problem of excessive incisor overbite was first aroused by one case where the result was better than in others of a similar type, although the original condition had seemed unpromising. This case was analysed, and then compared with other Class II, division 2 malocclusions, to try to discover the factors favourable in this instance.

## CASE REPORT

The following is a report of the case of P. C., who appeared to have a better result than other Class II, division 2 cases of a similar type.

HISTORY.—P. C. was 12 years old when he first attended. He was of average size for his age. He seemed helpful and co-operative. His parents also showed good co-operation, as evidenced by their determination to travel over 50 miles each way for his treatment.

P. C. was more like his mother than his father in appearance. His mother was assessed as a skeletal Class II on clinical examination, while his father was a skeletal Class I or mild Class III. His mother had a Class II, division 2 type of malocclusion, but, owing to some loss of teeth, was difficult to assess. There was one younger brother, also a Class II, division 2 type, but less severe.

P. C. had no relevant medical history.

His previous dental history included removal of submerged $\overline{E}|$ and impacted $\overline{5}|$, and conservation, but no previous orthodontic treatment.

CLINICAL EXAMINATION.—

*Soft Tissues.*—Competent lips, habitually together, with a high lip line; teeth-together swallow with no clinically detectable abnormal lip or tongue action during swallowing; normal speech; no habits affecting the oral cavity; inter-occlusal clearance slightly increased, but with no evidence of forward posture of mandible; the path of closure of the mandible was centric.

*Skeletal.*—Class II with average to low Frankfort–mandibular plane angle.

*Dental.*—Oral hygiene was good; the gingivæ were normal with no traumatic effects from the incisal bite; caries was minimal and well treated (*Fig.* 1 A).

*Occlusion.*—Class II, division 2; excessive incisor overbite with the mandibular incisors in light contact with the palatal mucosa; slightly increased overjet;

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Given at the meeting held on December 12, 1960.

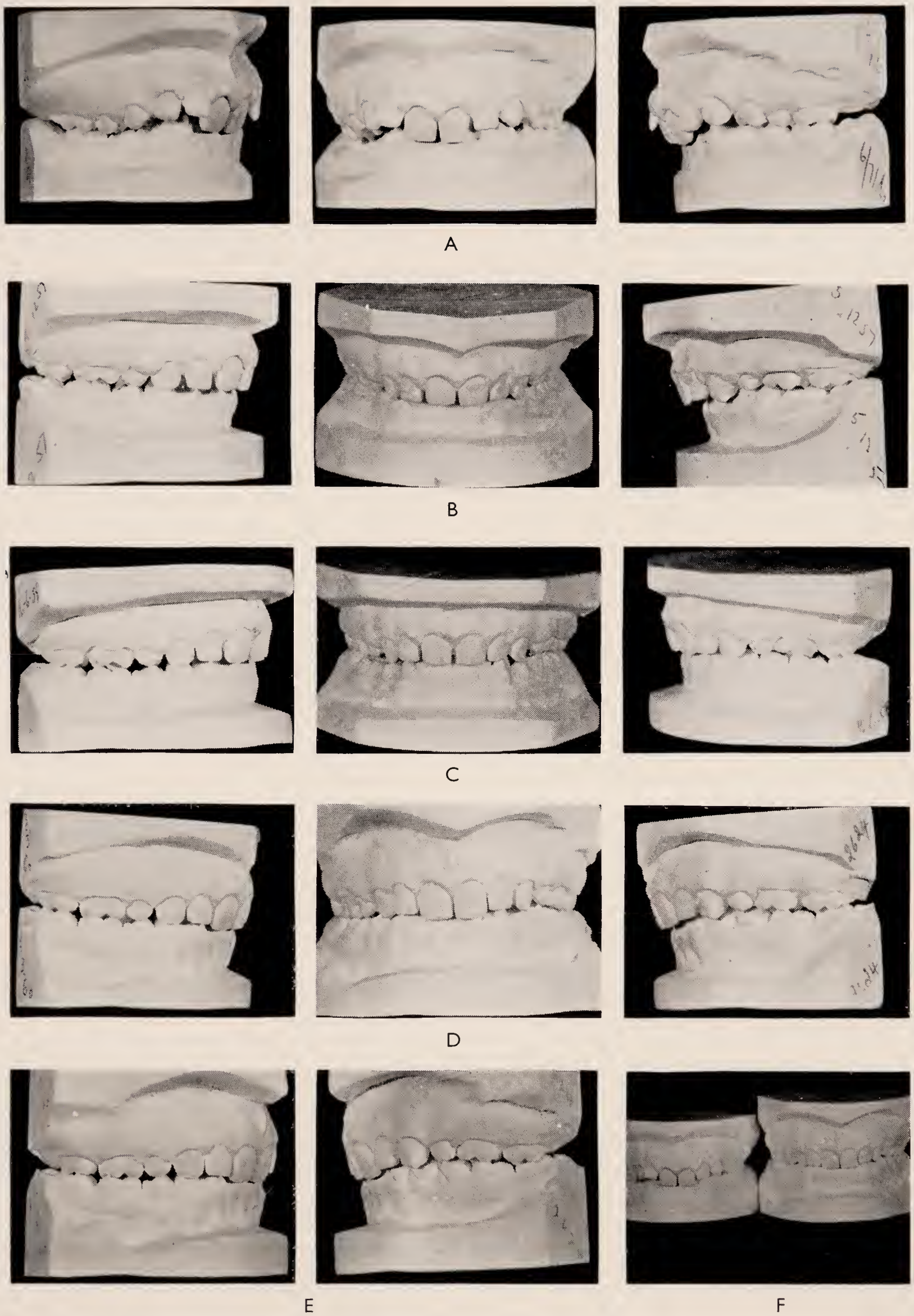



*Fig.* 1.—Models of P. C. A, Before treatment; B, After removal of fixed appliances; C, Six months later; D, At the end of retention; E, Six months out of retention; F, Model six months out of retention compared with original model.

retroclination of maxillary and mandibular incisors; anterior crowding in the maxillary arch; slight spacing in the mandibular arch was present, but the arch would have been crowded had $\overline{5|}$ been present; there was a shift of the mandibular centre line to the right; all teeth were erupted into the mouth except $\frac{87\ |78}{875|78}$; there was a buccal occlusion of $\underline{4|4}$ with forward position of maxillary buccal segments.

Radiographs.—

1. *Dental.*—These showed presence of $\frac{87|78}{87|78}$.

2. *Lateral Skull* (*Fig.* 2 A).—This confirmed the clinical findings of skeletal Class II, retroclined maxillary and mandibular incisors, and low Frankfort–mandibular angle.

The readings are as follows:—

S.$\hat{\text{N}}$.A. = 81·5°
S.$\hat{\text{N}}$.B. = 74·5°
Difference = 7·0°

| | |
|---|---|
| Maxillary incisors to Frankfort plane | = 91·0° |
| Maxillary incisors to maxillary plane | = 88·0° |
| Mandibular incisors to mandibular plane | = 79·0° |
| Angle between maxillary and mandibular incisors | = 168·5° |
| Frankfort–mandibular-plane angle | = 21·5° |
| Maxillary–mandibular-plane angle | = 26·0° |
| Gonial angle | = 117·5° |
| Nasion–sella–gnathion angle | = 69·0° |
| Overbite (orientated to Frankfort plane) | = 11·5 mm. |
| Overjet (orientated to Frankfort plane) | = 4·0 mm. |

$$\frac{\text{Facial height (nasion–gnathion)}}{\text{Sella–gnathion}}\ \text{percentage} = \frac{115}{120} = 96\%$$

Treatment.—Treatment consisted of extraction of $\underline{4|4}$ and completc multiband appliances to effect the following tooth movements, viz.:—

1. Retraction of $\underline{3|3}$.
2. Alinement, vertical depression, and distal apical movement of $\underline{21|12}$ (without proclination).
3. Closure of spacing in lower arch and depression of lower incisors with slight proclination. No attempt was made to restore symmetry in the mandibular arch.

The appliances consisted of modified Begg-type arches and the anchorage was intra-maxillary in the maxillary arch supplemented by inter-maxillary, to close spaces in the mandibular arch, and extra-oral traction at night.

Active treatment was completed in 13 months.

Passive arches were then inserted to retain for 2 months, after which time the bands were removed and upper and lower retention plates fitted immediately.

At this stage (*Fig.* 1 B) it may be seen that, in spite of my intention not to procline the maxillary incisors, they have increased their angulation and there is an increase in overjet. The mandibular incisors have been depressed, relative to the posterior teeth, and proclined, and the overbite has been reduced. There is no contact between maxillary and mandibular incisors. The buccal segments have moved forward during treatment and $\underline{5|5}$ are in poor contact. However, the spacing in the mandibular arch has been reduced and the alinement of anterior teeth is improved.

Altogether, the occlusion looks unstable and most unpromising.

Retention Period.—The retention plates were worn by day and at night for 6 months. They consisted of fitted labial bows from $\frac{3+3}{3+3}$ with the plate fitting around the incisors palatally and lingually. The upper plate was thickened anteriorly to form a slight bite plane to maintain the vertical position of the mandibular incisors.

At the end of 6 months I examined P. C. again and found that, although he had been wearing the plates all the time as directed, there was some alteration in the occlusion. The overjet was decreased and the relationship of the posterior teeth had altered (*Fig.* 1 C).

Another lateral skull radiograph was taken and compared with the one taken immediately after the bands were removed.

The readings are as follows, the figures in brackets being those of the radiograph immediately after treatment (*Fig.* 2 B, C):—

S.$\hat{\text{N}}$.A. = 81·0° (81·0°)
S.$\hat{\text{N}}$.B. = 75·0° (74·0°)
Difference = 6·0° (7·0°)

| | |
|---|---|
| Maxillary incisors to Frankfort plane | = 92·0° (98·0°) |
| Maxillary incisors to maxillary plane | = 90·0° (95·0°) |
| Mandibular incisors to mandibular plane | = 81·0° (85·0°) |
| Angle between maxillary and mandibular incisors | = 158·0° (152·0°) |
| Frankfort–mandibular-plane angle | = 29·0° (25·0°) |
| Maxillary–mandibular-plane angle | = 30·0° (28·0°) |
| Gonial angle | = 119·0° (118·0°) |
| Nasion–sella–gnathion angle | = 71·5° (70·0°) |
| Overbite (orientated to Frankfort plane) | = 7·0 mm. (7·0 mm.) |
| Overjet (orientated to Frankfort plane) | = 3·0 mm. (5·0 mm.) |

$$\frac{\text{Nasion–gnathion}}{\text{Sella–gnathion}}\ \text{percent} = \frac{139}{140} = 99\%\ \left(\frac{135}{135} = 100\%\right)$$

It may be seen from these figures that, although a relapse in proclination of maxillary incisors of 6° has occurred, the mandibular incisors have also relapsed by 4°, therefore the reduction in overjet is not entirely due to the falling back of the maxillary incisors.

A slight improvement of S.$\hat{\text{N}}$.A.–S.$\hat{\text{N}}$.B. difference is seen, although such a small difference may well be a tracing error.

The Frankfort–mandibular-plane angle, maxillary–mandibular-plane angle, and gonial angle have all increased slightly.

As I was not certain what was going to happen next, I decided to leave the retention plates and keep the case under observation. P. C. wore these plates day and night, the upper for 18 months and the lower for 1 year, after which time he went on to night-only retention for a further 6 months, retention being left off 6 months earlier in the lower arch. He was seen at intervals during this time, and the occlusion appeared to be steadily improving.

At the end of this period of retention, the incisors were in good contact, although the overbite was still deeper than normal. They were in a position of compromise to their angulations (*Fig.* 1 D).

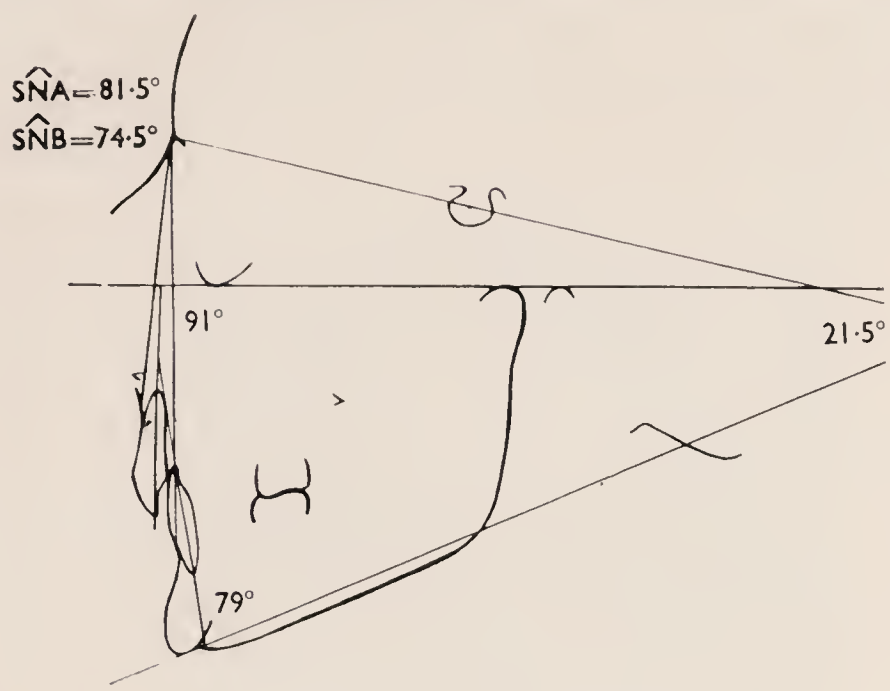
The buccal relationships are not perfect, due to asymmetrical loss in the mandibular arch.

The case was re-assessed and it was found that his soft-tissue morphology and behaviour were similar to those noted at his diagnosis 3 years earlier, i.e., normal. The

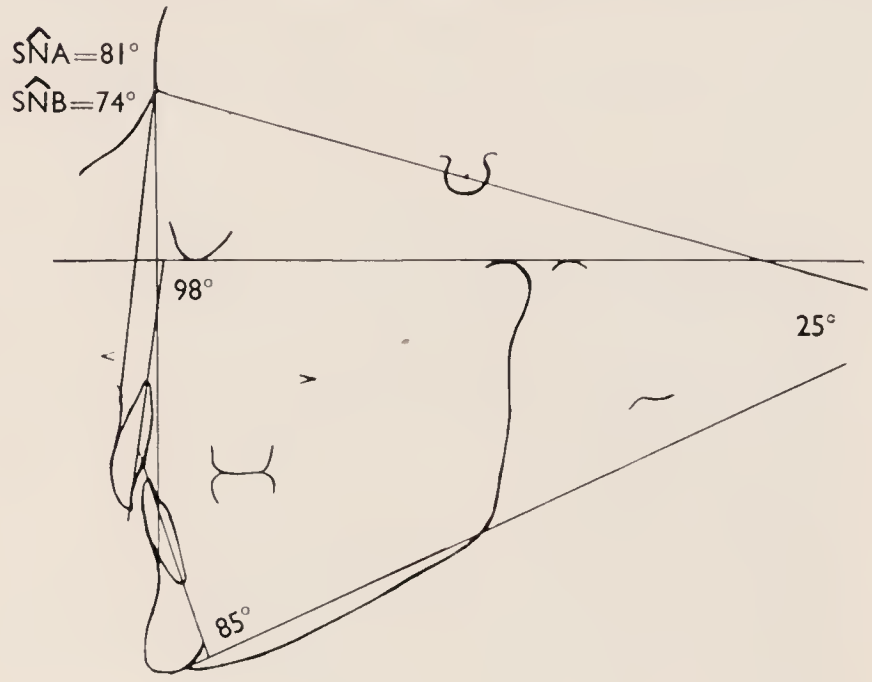
inter-occlusal clearance and path of closure of mandible were normal and centric. The lip line was still high, however (*Fig.* 3 A–C).

Physically, apart from his dental condition, considerable changes had occurred. His height had increased markedly (he was now 5 ft. 11 in.) and he was showing signs of development and maturation—deepening of the voice and the beginning of the growth of facial hair.

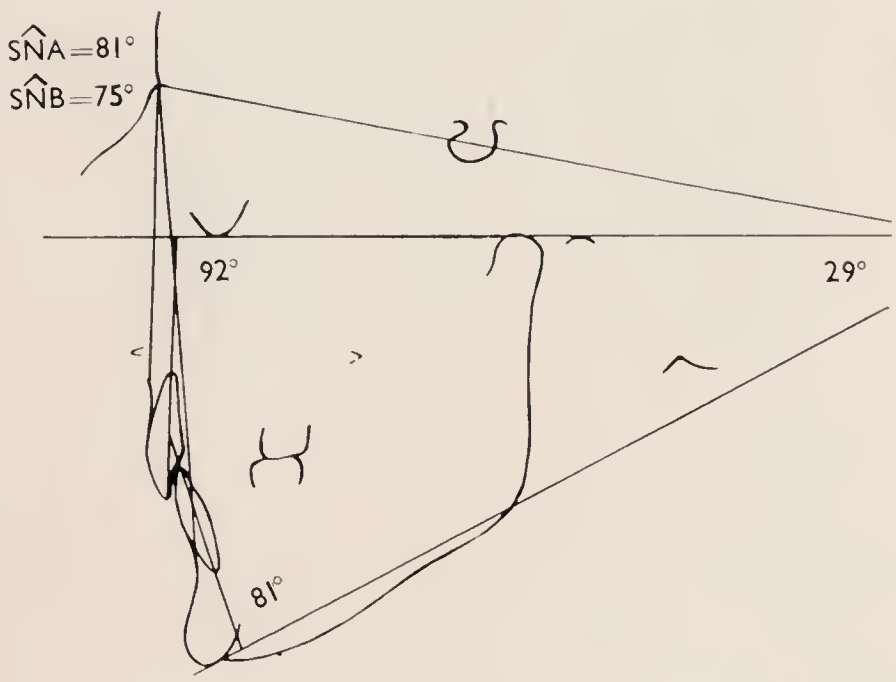
Six months after retention was discarded there was, if anything, a further improvement in occlusion. A




A




B

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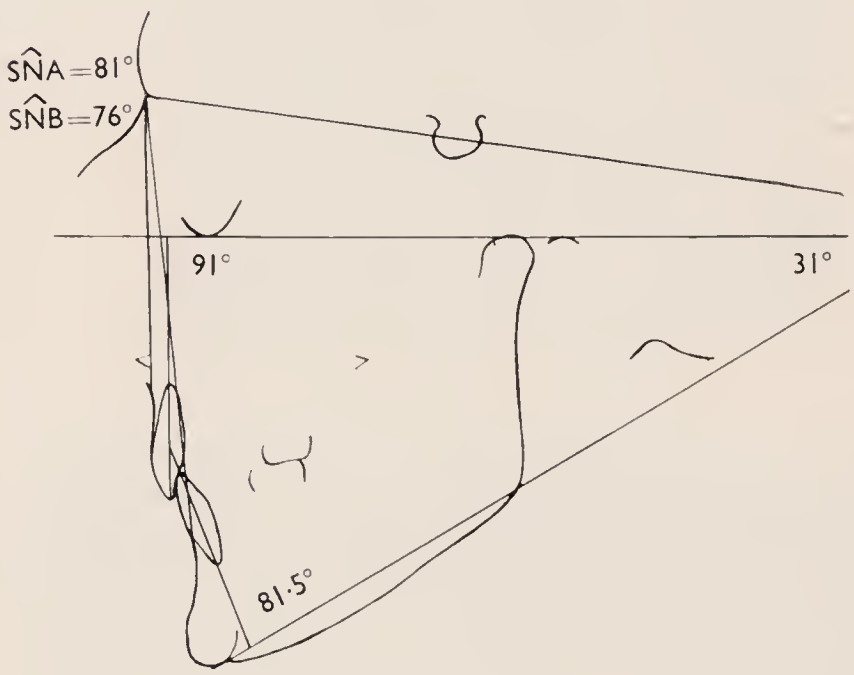
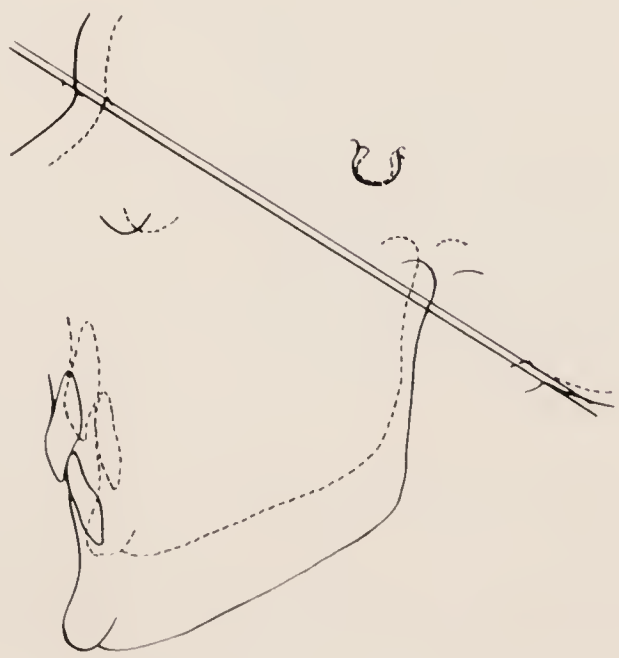



D



E

*Fig.* 2.—P. C.'s lateral skull tracings. A, Before treatment (12 years): B, After active treatment (13 years): C, During retention (14 years): D, Six months after retention (16 years): E, Superimposition of A and D.

follow-up lateral skull radiograph was taken, which showed the following measurements (*Fig.* 2 D):—

$$S.\hat{N}.A. = 81{\cdot}0^\circ$$
$$S.\hat{N}.B. = 76{\cdot}0^\circ$$
$$\text{Difference} = 5{\cdot}0^\circ$$

| | |
|---|---|
| Maxillary incisors to Frankfort plane | = 91·0° |
| Maxillary incisors to maxillary plane | = 87·0° |
| Mandibular incisors to mandibular plane | = 81·5° |
| Angle between maxillary and mandibular incisors | = 156·5° |
| Frankfort–mandibular-plane angle | = 31·0° |
| Maxillary–mandibular-plane angle | = 34·0° |
| Gonial angle | = 122·0° |
| Nasion–sella–gnathion angle | = 72·0° |
| Overbite (orientated to Frankfort plane | = 7·0 mm. |
| Overjet (orientated to Frankfort plane) | = 2·0 mm. |

$$\frac{\text{Nasion–gnathion}}{\text{Sella–gnathion}} \text{ percentage} = \frac{140}{143} = 98\%$$

The appearance is shown on models (*Fig.* 1 E).

The case has now been out of retention for about 1 year. It is stable, and, if anything, still improving slightly. P. C. is now nearly 16 years old.

There appears to be a slow, gradual increase in the Frankfort–mandibular, maxillary–mandibular, gonial, and nasion–sella–gnathion angles.

The overbite, once reduced, is maintained and the overjet is improved.

The slight alteration in $\frac{\text{nasion–gnathion}}{\text{sella–gnathion}}$ percentage may indicate an alteration in direction of growth from vertical to anterior-posterior and then swinging back to vertical.

## SUMMARY

The factors favourable and unfavourable to reduction of overbite in this case may be considered under the headings mentioned in the introduction.

**1. Factors present at the Time of Diagnosis.**—

*a. Favourable.*—(i) Normal soft tissues; (ii) Good condition of teeth and mouth; (iii) Co-operation good.

*Table I.*—Comparison of Measurements from P. C.'s Lateral Skull Tracings

| Measurement | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| S.N̂.A. | 81·5° | 81·0° | 81·0° | 81·0° |
| S.N̂.B. | 74·5° | 74·0° | 75·0° | 76·0° |
| Difference | 7·0° | 7·0° | 6·0° | 5·0° |
| Maxillary incisors to Frankfort plane | 91·0° | 98·0° | 92·0° | 91·0° |
| Maxillary incisors to maxillary plane | 88·0° | 95·0° | 90·0° | 87·0° |
| Frankfort–mandibular-plane angle | 21·5° | 25·0° | 29·0° | 31·0° |
| Maxillary–mandibular-plane angle | 26·0° | 28·0° | 30·0° | 34·0° |
| Mandibular incisors to mandibular plane | 79·0° | 85·0° | 81·0° | 81·5° |
| Gonial angle | 117·5° | 118·0° | 119·0° | 121·5° |
| Nasion–sella–gnathion angle | 69·0° | 70·0° | 71·5° | 72·0° |
| Overbite | 11·5 mm. | 7·0 mm. | 7·0 mm. | 7·0 mm. |
| Overjet | 4·0 mm. | 5·0 mm. | 3·0 mm. | 2·0 mm. |
| Nasion–gnathion / Sella–gnathion percentage | 96 | 100 | 99 | 98 |

1, Before treatment (12 years); 2, After active treatment (13 years); 3, During retention (14 years); 4, Six months after retention (16 years).

A comparison of models will show the changes in occlusion (*Fig.* 1 F), and a comparison of lateral skull tracings (*Fig.* 2 E) will show the changes seen on radiographs.

*Table I* shows the changes in lateral skull tracing measurements.

It can be seen that there has been a very slight improvement in S.N̂.A.–S.N̂.B. difference.

The maxillary incisors have been proclined and then returned to their original angulation. There was believed to be some distal movement of apices, which is difficult to demonstrate on radiographs.

The mandibular incisors were proclined and then relapsed again, but maintained a slight proclination of 3·5°.

Depression of maxillary and mandibular incisors was difficult to demonstrate, but appeared to be more in the mandibular arch.

*b. Unfavourable.*—(i) Skeletal Class II; (ii) Low Frankfort–mandibular-plane angle (believed to be associated with increased overbite); (iii) Early loss of $\overline{5}|$; (iv) Buccal occlusion of $\underline{4|4}$ and post-normal occlusion; (v) Retroclination of upper and lower incisors and an already excessive incisor overbite with palatal contact; (vi) Distance which patient had to travel.

At first the picture was not encouraging.

**2. Factors arising as a Result of Treatment.**—

*a. Favourable.*—(i) Appliances well tolerated and patient very co-operative; (ii) Decision

to aeeept an asymmetrieal mandibular areh prevented further eollapse of labial segments; (iii) It was possible to depress and proeline the mandibular ineisors, and to provide eontacts to support the labial segments.

*b. Unfavourable.*—(i) Proelination of maxillary ineisors prevented a eontaet being made between upper and lower ineisors to maintain the overbite; (ii) The asymmetrieal loss in the lower areh, together with symmetrieal loss in the upper areh, prevented a good bueeal oeelusion from being produeed; (iii) The upper bueeal segments were moved forward during treatment.

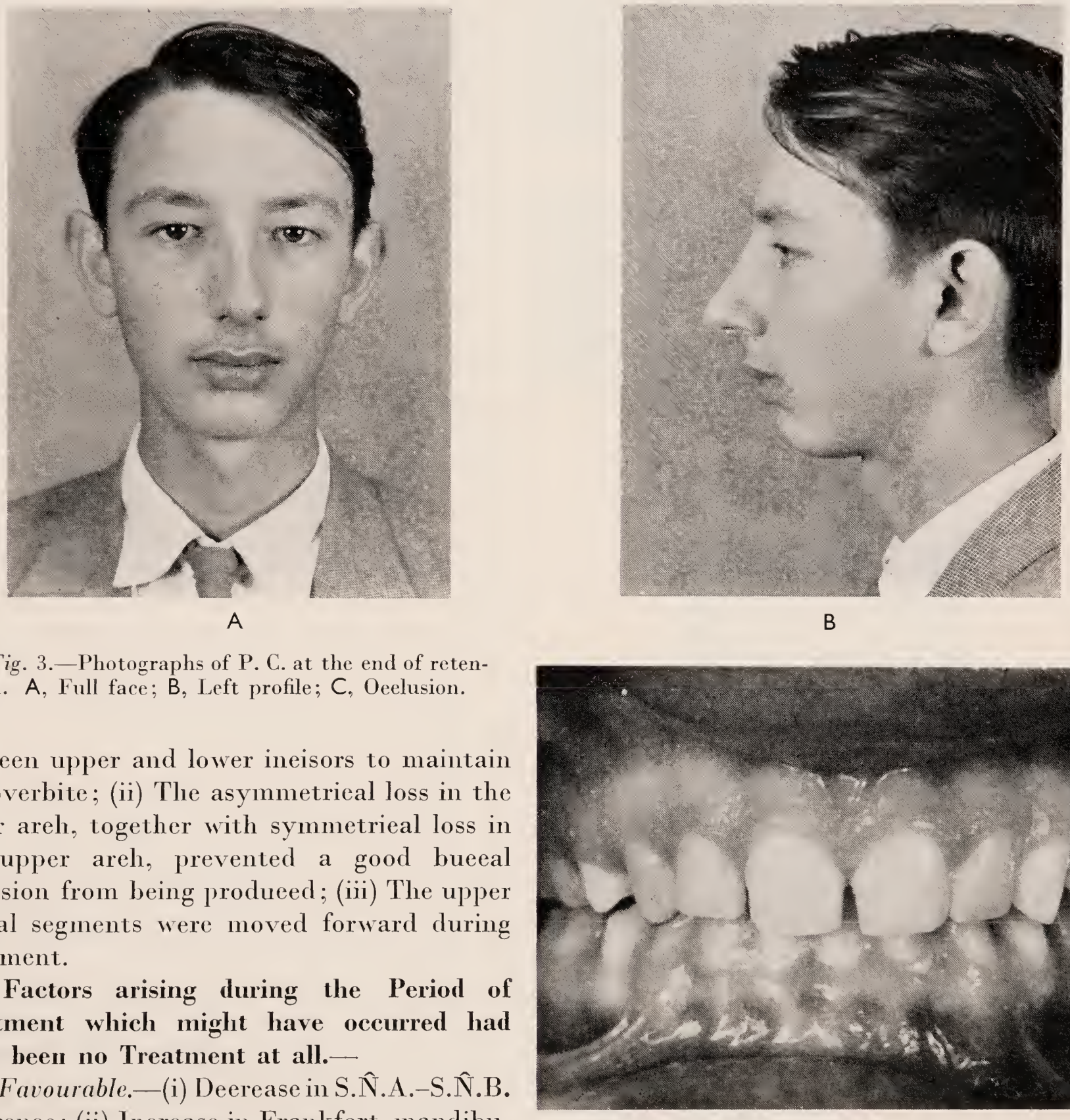
**3. Factors arising during the Period of Treatment which might have occurred had there been no Treatment at all.—**

*a. Favourable.*—(i) Deerease in S.N̂.A.–S.N̂.B. differenee; (ii) Inerease in Frankfort–mandibular and maxillary–mandibular angles may have improved the ineisor relationship; (iii) The alteration in the pereentage $\frac{\text{nasion–gnathion}}{\text{sella–gnathion}}$ may show a greater downward growth; (iv) General inerease in height and development.

*b. Unfavourable.*—None were found in this ease. All the tendeneies appeared to favour improvement.

**4. Factors present at the End of Treatment.—**

*a. Favourable.*—(i) The retention period was obviously favourable in this ease. Had the mandibular ineisors not been held in the vertieal plane they may well have over-erupted again; (ii) The relapse of ineisors into musele balanee as well as into eontaet helped to make the ease stable. The upper ineisors were at the same inelination as at the beginning of treatment; (iii) Cuspal eontaets on the posterior



A B C

*Fig.* 3.—Photographs of P. C. at the end of retention. A, Full face; B, Left profile; C, Oeelusion.

teeth may have, by inclined plane action, aided the settling of the occlusion and may have produced some forward element; (iv) Muscle action on the proclined maxillary incisors may have moved the entire maxillary arch distally;

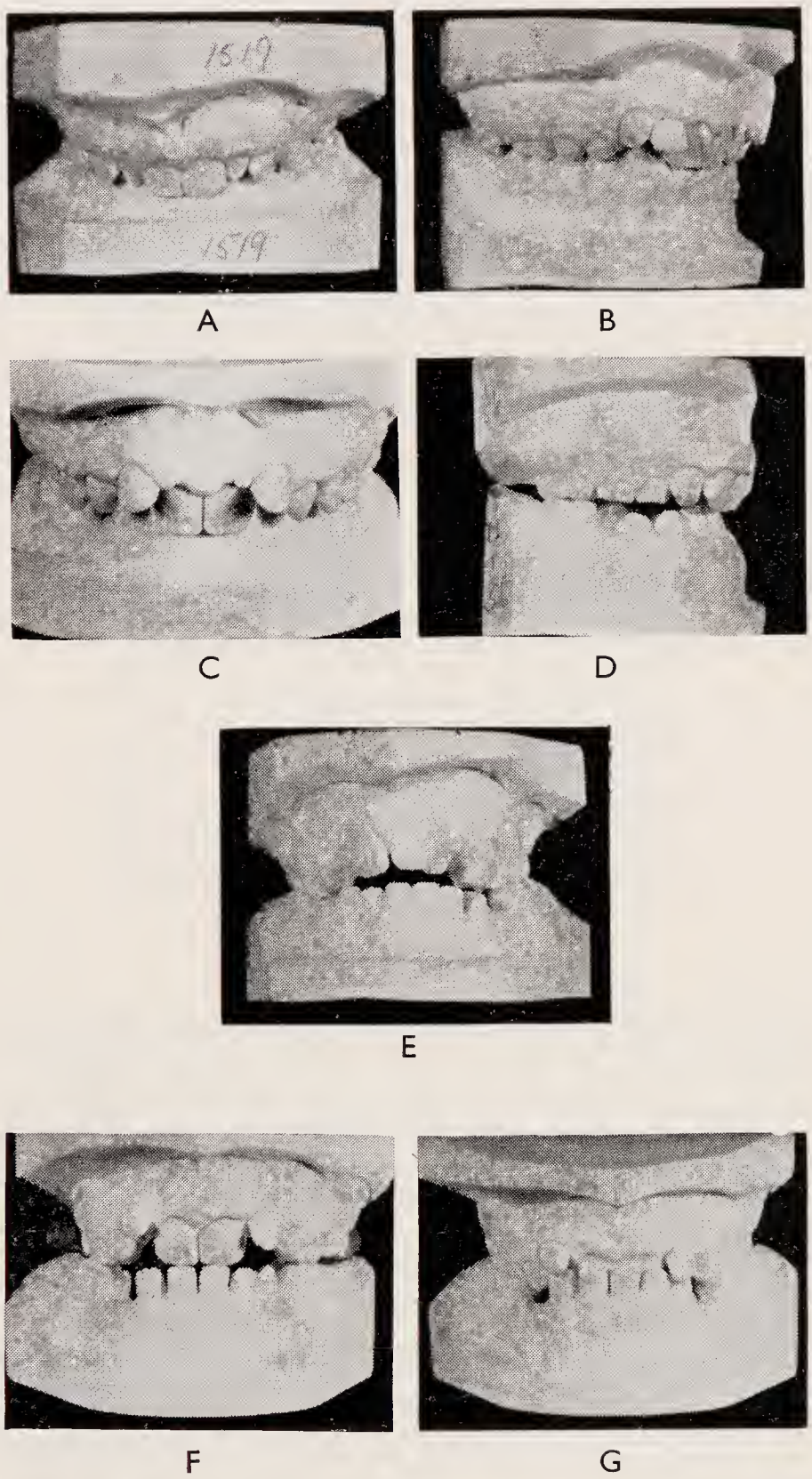



*Fig.* 4.—Models of different types of Class II, division 2 cases. A, Very deep incisor overbite; B, Extreme overcrowding; C, Very proclined lateral incisors; D, Reduced anterior overbite; E, Anterior open bite; F, Reversed overjet—open; G, Reversed overjet—closed.

(v) Growth may have brought the lower arch forward (certainly there was no forward bite of accommodation in this case at the end of treatment); (vi) The improved skeletal relationships may have aided improvement.

*b. Unfavourable.*—The overjet which, had there been no retention, might have resulted in relapse into an extreme excessive incisor overbite again.

Thus it can be seen, in this particular case, that an unfavourable beginning with, apparently, many unfavourable factors present, could still result in an acceptable end-product by the emergence of favourable factors to balance these already present.

Having examined one case, it was thought that it might be interesting to investigate more Class II, division 2 cases and to follow through as many as possible in order to try to find favourable factors common to all cases and predictable from the beginning of treatment. It was decided, therefore, to select cases for comparison.

## SELECTION OF CASES FOR COMPARISON

One hundred and five cases of Class II, division 2 type were selected from patients under treatment at the Royal Dental Hospital and the Hospital for Sick Children. Sixty-nine of these were under my own care. I chose those classified as Class II, division 2 on clinical examination, with at least half a unit of post-normality of the posterior occlusion and with retroclined maxillary incisors. The ages ranged from 11 to 14 years inclusive. Severe cases under permanent retention were discarded.

At first, the original models were examined.

It was interesting to note how many different types of malocclusion fall into this class, and it was realized how artificial these accepted classifications may be, although they are convenient (*Fig.* 4).

Next, the original lateral skull radiographs were traced and examined. It was then found that some cases, although classified as division 2 type by clinical investigation, were really division 1 type from tracings. This was due to the abnormal angulation of crown to long axis, which made the teeth appear to be retroclined.

This was seen in many cases, although in most of them the long axis was retroclined as well, and these could still be included in the selected group. As some other workers are at

present investigating this field, I shall not discuss crown–root angulation further at this point.

As well as using original models and lateral skull tracings, the soft tissues were also recorded clinically at the time of diagnosis.

## ANALYSIS OF 105 CASES

**Occlusal.**—The analysis of occlusions may be seen in *Table II A, B*. These figures were produced from a study of models and lateral skull tracings.

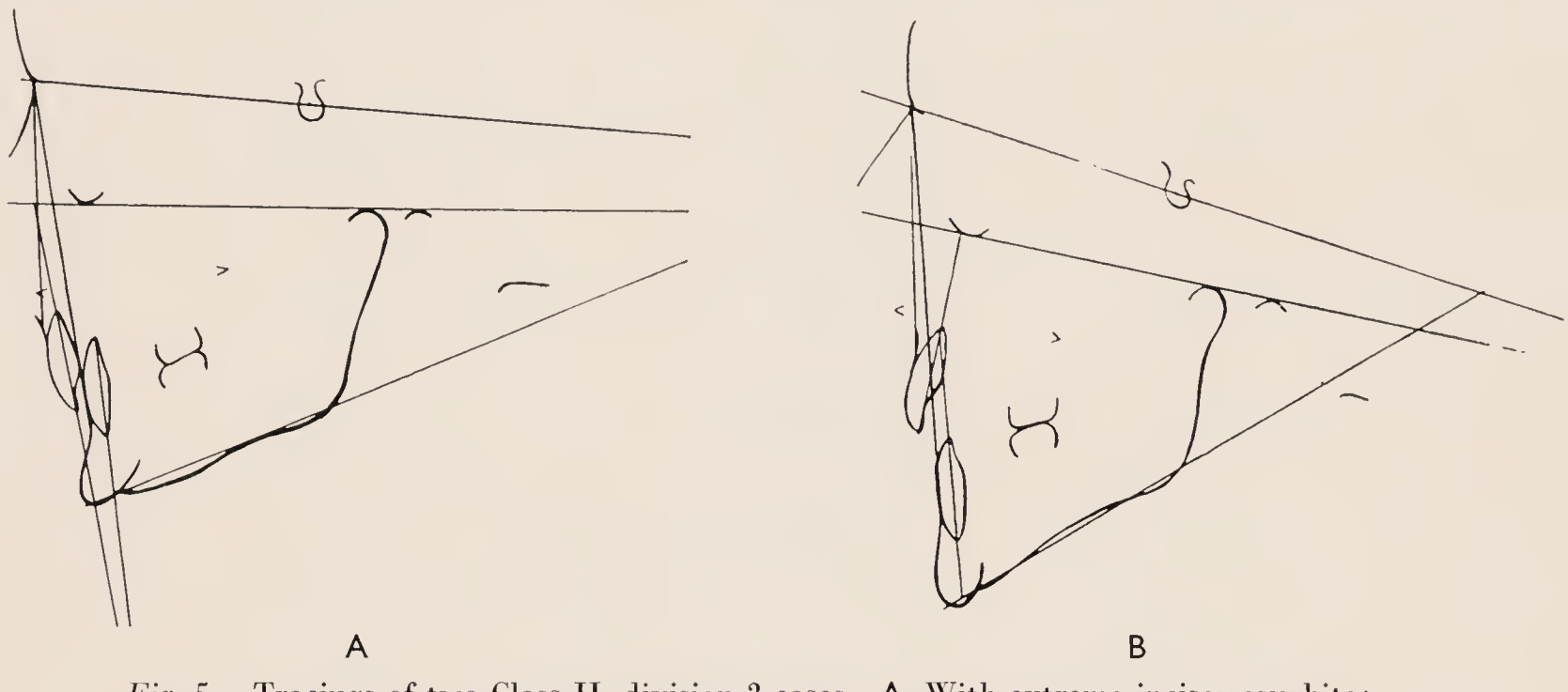
In *Table II A* the labial segments were analysed under the following headings, viz.:—(1) Angulation of incisors; (2) Overbite and overjet; (3) Contact made by mandibular incisors; (4) Abnormal or absent teeth; (5) Degree of crowding or spacing; (6) Position of mandibular centre line.

1. *Angulation of Incisors.*—It may be seen from these figures that all the maxillary central incisors in these cases were retroclined. They were all angulated at less than 104° to the Frankfort plane, the normal being taken as 105°–111° to the Frankfort plane. This plane was used because of its clinical significance. Measurements were also made to the maxillary plane and almost identical results were found, except in the few cases where the two planes were divergent.

The readings are divided in an arbitrary manner merely to show the range covered. Similarly, the readings for mandibular incisor angles to mandibular plane are arbitrarily divided.

The mandibular incisors were largely retroclined, although many only slightly. Thirteen cases had proclined lower incisors. The normal was taken as $90° \pm 4°$ to the mandibular plane.

2. *Overbite* (orientated to Frankfort plane).—Particular attention was paid to determining the degree of overbite. The overlap of incisors, from incisal tips of the maxillary central incisors to the incisal tips of the mandibular central incisors, was measured in millimetres. Where there was a discrepancy in length, the mean was taken. Then the labial surfaces of the clinical crowns of the mandibular central



A B

*Fig.* 5.—Tracings of two Class II, division 2 cases. A, With extreme incisor overbite; B, With anterior open bite.

incisors were measured in mm. and, again, the mean was taken if there was a discrepancy in length. Then the proportion of overlap to crown length was found. The normal was taken as $\frac{1}{4}$–$\frac{1}{3}$. Actual measurements were not used at this stage, as an overlap of a certain measurement may be normal on a large tooth but excessive on a small tooth, and great variation in tooth size was found. It may be seen from the figures that nearly all the cases (95/105) had an overbite greater than $\frac{1}{3}$ of the length of the clinical crown of the mandibular incisor. Eight had a normal overbite and 2 had reduced or open bite. That great differences were found can be seen on these two lateral radiograph tracings (*Fig.* 5 A, B).

3. *Overjet* (orientated to Frankfort plane).—This was measured as the distance from the tip

*Table II.*—Analysis of Occlusions of 105 Class II, division 2 Cases

*A. LABIAL SEGMENTS*

| Measurement | | No. of Cases (105) |
|---|---|---|
| Angulation of maxillary incisors | <85° | 14 |
| | 86°– 95° | 35 |
| | 96°–104° | 36 |
| | 105°< | — |
| Angulation of mandibular incisors | <75° | 19 |
| | 76°–85° | 30 |
| | 86°–94° | 43 |
| | 95° < | 13 |
| Contact of mandibular incisors | With maxillary incisors | 59 |
| | With palatal mucosa | 36 |
| | None | 10 |
| Overbite | Increased | 95 |
| | Normal | 8 |
| | Decreased | 2 |
| Overjet | Increased | 17 |
| | Normal | 85 |
| | Decreased | 2 |
| | Reversed | 1 |
| Crowding | Maxillary | 86 |
| | Mandibular | 68 |
| Spacing | Maxillary | 4 |
| | Mandibular | 6 |
| Abnormal teeth | Reduced lateral incisors | 2 |
| | Increased crown/root angle | 55 |
| Absent teeth | Absent lateral incisors | 2 |
| Mandibular centre line not coincident with maxillary | | 63 |

*B. BUCCAL SEGMENTS*

| Measurement | | | No. of Cases (105) |
|---|---|---|---|
| Premature loss | Deciduous | Maxillary | 24 |
| | | Mandibular | 36 |
| | Permanent | Maxillary | 9 |
| | | Mandibular | 11 |
| Post normality | ½ unit | | 65 |
| | 1 unit | | 31 |
| | More than 1 unit | | 9 |
| Crowding | Maxillary | | 29 |
| | Mandibular | | 32 |
| Spacing | Maxillary | | 7 |
| | Mandibular | | 8 |
| Cross-bite | Right | | 4 |
| | Left | | 7 |

of the maxillary central incisors to the labial surface of the mandibular central incisors. The normal was taken as 2 mm. Eighty-five cases were found to have a normal overjet, 17 were increased, 2 reduced, and 1 actually reversed (*Fig.* 4).

3. *Contact made by Mandibular Incisors.*—The contact made by the mandibular incisors was assessed according to whether they touched the maxillary incisors or palatal mucosa or nothing at all, when the posterior teeth were in occlusion. Most of the cases had contact with teeth, the deeper ones with palatal mucosa, and a few were actually causing stripping of the gingivæ. Ten cases had no contact at all.

The cases previously mentioned as having normal or reduced over-bite fall into the same group of 10 cases mentioned here as having no contact. This group is peculiar, and will be discussed further when more aspects of the cases are examined.

4. *Abnormal or Absent Teeth.*—Two cases had absent lateral incisors. Another 2 cases had lateral incisors of reduced size. Fifty-five cases had abnormal crown–root angulation.

5. *Crowding and Spacing.*—It was found that nearly all the cases were crowded in the maxillary labial segment (86/105) and very few spaced (4). In the mandibular labial segment, 68 were crowded and 6 spaced.

6. *Centre Line.*—The centre lines were not coincident in 63 of the cases.

*Table III.*—Analysis of Skeletal Patterns of 105 Class II, division 2 Cases

| Measurement | | No. of Cases (105) |
|---|---|---|
| Classification | I | 36 |
| | Mild II | 55 |
| | Severe II | 9 |
| | III | 5 |
| Frankfort–mandibular-plane angle | <24° | 26 |
| | 25°–30° | 57 |
| | 31°< | 22 |
| Maxillary–mandibular-plane angle | <24° | 23 |
| | 25°–30° | 52 |
| | 31°< | 30 |
| Gonial angle | <119° | 39 |
| | 120°–125° | 48 |
| | 126°< | 26 |
| Nasion–sella–gnathion angle | <66° | 27 |
| | 67°–71° | 52 |
| | 72°< | 26 |
| $\frac{\text{Nasion–gnathion}}{\text{Sella-gnathion}}$ percentage | <97 | 21 |
| | 98–102 | 56 |
| | 103< | 28 |

The buccal segments were then analysed (*Table II B*) under the following headings: (1) Premature loss of teeth; (2) Degree of post-normality; (3) Crowding or spacing; (4) Cross-bites.

1. *Premature Loss of Teeth* (Posterior).—Premature loss of deciduous and permanent teeth was noted in mandibular and maxillary arches. The permanent teeth lost were mainly first molars, although two first premolars were prematurely lost in one case.

2. *Degree of Post-normality.*—This was measured in units, one unit being the mesio-distal width of the first premolar. No cases had less than $\frac{1}{2}$ unit of post-normality.

3. *Crowding or Spacing.*—As with the labial segments, very few cases showed spacing, more were crowded.

4. *Cross-bites.*—Very few cases had cross-bites, and those noted were individual teeth rather than the whole segment.

**Skeletal.**—The skeletal analysis of 105 cases is shown in *Table III.*

The following measurements were made:—

1. *Skeletal Classification.*—This was assessed clinically and verified with lateral skull radiograph tracings. On the tracings, the skeletal patterns were found by correction of angulation of incisors and by S.N̂.A.–S.N̂.B. difference measurements. The S.N̂.A.–S.N̂.B. difference measurements were then taken as follows:—

| | | |
|---|---|---|
| | Sk. I | =Difference 2°–4° |
| Mild | Sk. II | =Difference 5°–7° |
| Severe | Sk. II | =Difference 8°< |
| | Sk. III | =Difference <1° |

Most were Sk. II and Sk. I, but not many Sk. III or severe Sk. II.

2. *Frankfort–mandibular-plane Angles and Maxillary–mandibular-plane Angles.*—These were divided arbitrarily to show the range covered and seemed fairly evenly divided amongst the groups, not necessarily having low values.

3. *The gonial angle* was measured, which again showed considerable variation.

4. *The nasion–sella-gnathion angle* was measured to attempt to predict the direction of growth. The results were again spread over a wide range.

5. *The percentage* $\frac{\textit{nasion–gnathion}}{\textit{sella –gnathion}}$ was used to attempt to show variations in growth from vertical to forward and downward. These values again varied considerably. Percentages were used to avoid errors possibly introduced by variations in radiographs.

**Soft Tissues.**—The soft-tissue morphology and behaviour is shown in *Table IV.* The following points were investigated: (1) Lip line; (2) Lip posture; (3) Swallowing action; (4) Habits; (5) Speech; (6) Inter-occlusal clearance; (7) Mandibular posture; (8) Path of closure of mandible.

1. *The lip line* was taken as normal if it lay at the junction of the incisal $\frac{1}{3}$ and gingival $\frac{2}{3}$ of the labial surface of the maxillary incisors. Nearly all the cases had high lip lines.

2. *Lip Posture.*—It is unfortunate that we had no way of recording musculature except by making notes of clinical findings. It is impossible to check these as it is with models or radiographs. On checking the follow-up cases I am sure that ideas and clinical assessment may have changed during the intervening years since some of the cases were originally assessed. Thus, cases originally called "competent" may now be called "slightly incompetent, habitually together". Therefore I publish the findings, but with the reservation that they may not be quite accurate.

3. *Swallowing Action.*—Again, observations made at the time of diagnosis may be interpreted differently at the present time, but the figures shown should give a rough estimate of the different types. It may well be that at this time the contraction of lips prior to swallowing (to collect saliva) may have been misinterpreted as contraction actually during swallowing. However, the cases noted as having tongue thrusts fit in with the cases with no incisal contact, which is interesting.

4. *Habits.*—Very few of these patients had sucking habits of any kind, nor were any remembered during earlier years. However, we should remember that patients' memories are not always reliable.

5. *Speech.*—This was not checked in any expert fashion, but sounds were noted during the course of conversation. No abnormalities were found.

6. *Inter-occlusal Clearance, Mandibular Posture, and Paths of Closure.*—Again, these are factors which may not have been recorded in each case, which would, I think, explain the low numbers.

At first sight, remembering that all but 10 of the cases had increased incisor overbite, it would appear that there is little correlation between overbite and other factors. The skeletal, occlusal, and soft-tissue analyses seem to vary so much, and few factors seem to stand out as being invariably present.

However, the two extremes, i.e., those with normal or reduced overbite and those with really deep overbite, with palatal contact, were separated and further investigated. It was felt that factors associated with the normal or reduced may well be favourable to reduction of overbite. Factors associated with the very deep might prove to be a guide to the unfavourable factors.

It was found that the only factor persistently present in the cases of normal or reduced overbite was abnormal soft-tissue behaviour and habits, i.e., tongue thrusting and sucking habits. All other factors appeared to be the same as in the main group. Thus it seems that, in abnormal circumstances, a further abnormal factor is likely to counteract other abnormal forces and produce a more normal result. However, it must be remembered that there was no incisal contact in these cases.

In the extreme cases with palatal contact no one persistent factor was found which was present in every case, which is interesting, as this means that an increased overbite is due not to one factor only but to many and not always the same ones. The following findings may be interesting: of these cases (36):—

1. Eighty-seven per cent had a Skeletal II base (not necessarily severe).
2. Seventy-five per cent had a tooth-apart swallow with some contraction of the circumoral musculature.
3. Sixty-seven per cent had early loss of units in the mandibular arch.
4. The retroclination of incisors was of the more severe type.
5. More of the cases had a more severe type of post-normality of posterior occlusion.

However, with only 10 cases of one type and 36 of the other, it is not possible to show anything but a tendency to an association.

*Table IV.*—Analysis of Soft Tissues of 105 Class II, division 2 Cases

| Soft Tissues | | No. of Cases (105) |
|---|---|---|
| Lip line | Normal | 12 |
| | High | 93 |
| Lip posture | Competent | 66 |
| | Incompetent | 39 |
| | Habitually together | 94 |
| | Habitually apart | 11 |
| Swallowing action | Teeth together | 64 |
| | Teeth apart | 41 |
| | Contraction of lips | 77 |
| | Anterior tongue thrust | 10 |
| Habits | Thumb-sucking | 3 |
| | Lip-sucking | 1 |
| Speech | Anterior sigmatism | — |
| | Dislalia | — |
| Inter-occlusal clearance | Normal | 71 |
| | Increased | 34 |
| Posture of mandible | Normal | 71 |
| | Forward | 10 |
| | Open | 24 |
| Path of closure of mandible | Protrusive | 1 |
| | Lateral | 4 |
| | Centric | 87 |
| | Retrusive | 13 |

*Table V.*—Comparison of Occlusions Before and After Treatment in 49 Cases

*A. LABIAL SEGMENTS*

| Measurement | | Overbite Reduced (27) | | Overbite Unchanged (12) | | Overbite Increased (10) | |
|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| Angulation of maxillary incisors | <85° | 4 | 3 | 3 | 2 | 2 | 2 |
| | 86°–95° | 11 | 12 | 5 | 6 | 3 | 2 |
| | 96°–104° | 12 | 12 | 4 | 4 | 5 | 6 |
| | 105°< | — | — | — | — | — | — |
| Angulation of mandibular incisors | <75° | 5 | 3 | 1 | 1 | 1 | 2 |
| | 76°–85° | 8 | 10 | 4 | 6 | 4 | 1 |
| | 86°–94° | 10 | 7 | 3 | 3 | 5 | 6 |
| | 95°< | 4 | 7 | 4 | 2 | — | 1 |
| Overjet | Increased | 1 | — | 1 | — | 1 | 4 |
| | Normal | 25 | 27 | 11 | 12 | 9 | 6 |
| | Decreased | 1 | — | — | — | — | — |
| Crowding | Maxillary | 24 | 6 | 10 | 2 | 9 | 1 |
| | Mandibular | 24 | 12 | 10 | 5 | 9 | 2 |
| Spacing | Maxillary | — | — | 1 | 1 | — | — |
| | Mandibular | 1 | — | — | 2 | 1 | 7 |
| Contact of mandibular incisors | with maxillary incisors | 12 | 24 | 6 | 6 | 7 | 4 |
| | with palatal mucosa | 12 | — | 5 | 5 | 3 | 6 |
| | None | 3 | 3 | 1 | 1 | — | — |
| Abnormal or absent teeth | Reduced lateral incisors | — | — | — | — | — | — |
| | Increased crown/root angle | 12 | 12 | 6 | 6 | 8 | 8 |
| | Absent incisors | — | — | 1 | 1 | — | — |
| Mandibular centre line not coincident with maxillary | | 12 | 10 | 4 | 6 | 5 | 7 |

*B. BUCCAL SEGMENTS*

| Measurement | | | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|---|---|
| Premature loss | Deciduous | Maxillary | 9 | 2 | 4 |
| | | Mandibular | 10 | 2 | 6 |
| | Permanent | Maxillary | 2 | 1 | — |
| | | Mandibular | 2 | — | — |
| Unit of post-normality | ½ unit | | 15 | 7 | 2 |
| | 1 unit or more | | 12 | 5 | 8 |

| | | 1st | 2nd | 1st | 2nd | 1st | 2nd |
|---|---|---|---|---|---|---|---|
| Crowding | Maxillary | 12 | 2 | 1 | — | 2 | — |
| | Mandibular | 23 | 12 | 2 | — | 1 | — |
| Spacing | Maxillary | 1 | 5 | 2 | — | 1 | — |
| | Mandibular | 2 | — | 1 | 4 | 1 | 4 |

## ANALYSIS OF TREATED CASES

From the 105 cases analysed above, 49 were followed through treatment into the post-retention period. Several cases had been two or three years out of retention when re-called—some less, but every case had been at least six months out of retention. The loss of cases was due mainly to patients discontinuing treatment for various reasons or to their not reporting for the final check-up.

The 49 cases were examined for reduction of incisor overbite when compared with the original models. This time actual measurements in mm. of the vertical distance between the maxillary and mandibular incisal tips were noted and compared with the original distance. Proportions could not be used because gingival recession had occurred in some cases which would make the clinical crown larger, thus disturbing the values for the proportions.

The cases were then divided into three groups:—

1. Those where a reduction of overbite had been achieved and maintained in the post-retention period.

2. Those where the overbite was exactly the same as at the beginning of treatment, although the rest of the occlusion may have been greatly improved.

3. Those where the excessive overbite had actually increased, i.e., become worse, in spite of improvement in the occlusion otherwise.

27/49 were in the first group; 12/49 were in the second group; 10/49 were in the third group.

The final grouping showed little relation to the original degree of overbite except in the very severe cases which were in the second or third group.

These 49 cases were then analysed according to the above grouping, for occlusal, skeletal, and soft-tissue variations.

*Table VI.*—Comparison of Soft Tissues Before and After Treatment in 49 Cases

| | | Overbite Reduced (27) | | Overbite Unchanged (12) | | Overbite Increased (10) | |
|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| Lip line | Normal | 3 | 5 | — | — | — | — |
| | High | 24 | 22 | 12 | 12 | 10 | 10 |
| Lip posture | Competent | 27 | 20 | 10 | 8 | 10 | 2 |
| | Incompetent | — | 7 | 2 | 4 | — | 8 |
| | Habitually together | 27 | 27 | 10 | 12 | 10 | 10 |
| | Habitually apart | — | — | 2 | — | — | — |
| Swallowing action | Teeth together | 10 | 15 | 7 | 8 | 4 | 2 |
| | Teeth apart | 17 | 12 | 5 | 4 | 6 | 8 |
| | Contraction of lips | 20 | 12 | 12 | 8 | 10 | 10 |
| | Anterior tongue thrust | 2 | 2 | — | — | — | — |
| Habits | Thumb-sucking | — | — | — | — | — | — |
| | Lip-sucking | — | — | — | — | — | — |
| Inter-occlusal clearance | Normal | 27 | 27 | 10 | 10 | 2 | — |
| | Increased | — | — | 2 | 2 | 8 | 10 |
| Posture of mandible | Normal | 27 | 27 | 10 | 10 | 2 | — |
| | Forward | — | — | 2 | 2 | 6 | 7 |
| | Open | — | — | — | — | 2 | 3 |
| Path of closure of mandible | Protrusive | — | — | — | — | — | — |
| | Retrusive | — | — | 2 | 2 | 6 | 7 |
| | Lateral | — | — | — | — | — | — |
| | Centric | 27 | 27 | 10 | 10 | 4 | 3 |

**Occlusal.**—*Table V A* shows the comparison of labial segments before and after treatment, the first column in each group being

before treatment, the second column after treatment.

The incisal angulations do not seem to bear much relationship to the reduction achieved. Similarly, the figures for overjet and crowding seem to be almost identical in all three groups.

The figures for incisal contact are more definite, the cases in the first group all resulting in tooth contact except those where there was no contact originally. These 3 odd cases did, however, show a reduction, although they were normal to start with, and this reduction was maintained. In the second group the contacts are the same and in the third group the contacts are worse.

Figures for abnormal teeth and centre line do not seem to be significant at all.

*Table V B* shows the comparison of buccal segments.

The original state of premature loss does not seem to have any effect on the end result.

The degree of post-normality seems to be proportionally worse in cases which did not improve.

Crowding in the buccal segments seems to have more of a beneficial effect on reduction than crowding in the labial segment, and the cases still crowded after treatment are the ones in the first group.

Therefore, the favourable occlusal factors appear to be: (1) Establishment of contact between incisors; (2) Original post-normality not too severe; (3) Crowding of mandibular arch, especially the buccal segments.

*Table VII.*—Original Skeletal Measurements of 49 Treated Cases

| | | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|---|
| Classification | I | 15 | 3 | 1 |
| | Mild II | 9 | 6 | 5 |
| | Severe II | 1 | 2 | 4 |
| | III | 2 | 1 | — |
| Frankfort–mandibular-plane angle | <24° | 6 | — | 2 |
| | 25°–30° | 15 | 10 | 6 |
| | 31°< | 6 | 2 | 2 |
| Maxillary–mandibular-plane angle | <24° | 5 | 2 | 3 |
| | 25°–30° | 14 | 8 | 5 |
| | 31°< | 7 | 2 | 2 |
| Gonial angle | <119° | 11 | 2 | 3 |
| | 120°–125° | 7 | 8 | 5 |
| | 126°< | 9 | 2 | 2 |
| Nasion–sella–gnathion angle | <66° | 5 | 5 | 2 |
| | 67°–71° | 17 | 5 | 7 |
| | 72°< | 5 | 2 | 1 |
| $\frac{\text{Nasion–gnathion}}{\text{Sella-gnathion}}$ percentage | <97 | 13 | 4 | 4 |
| | 98–102 | 10 | 5 | 3 |
| | 103< | 4 | 3 | 3 |

**Soft Tissues.**—The soft tissues are shown in *Table VI.*

The variation before and after treatment is more likely to be a change in clinical assessment than an alteration in the soft tissues.

Very little significant difference can be seen between the three groups. Perhaps the third group has a higher proportion of teeth-apart swallows, but the numbers are rather small to prove this. The posture and inter-occlusal clearance certainly seem to be normal in the first group and markedly open and forward in the third group. These may not be causes of the over-bite, but present because of it.

The lip line seems high in most cases.

Thus, very little can be said of the soft tissues except that the worst cases seem to have some relation to a teeth-apart swallowing action.

**Skeletal.**—*Table VII* shows the original skeletal relationships in these cases.

The majority of the cases where reduction was effected appear to be Skeletal I, while the other groups fall mainly into Skeletal II category. There seems very little difference in the other measurements.

Further lateral skull radiographs taken in the post-retention period were traced and compared with the originals. The results are shown in *Table VIII*, and it seems that some alterations have occurred. Changes of less than 3° were disregarded as these could be due to tracing errors.

In the first group, 4 cases show a decrease in S.N̂.A.–S.N̂.B. difference, 8 show an increase in Frankfort–mandibular angle, 6 a difference in maxillary–mandibular angle, and 3 increases in gonial and nasion–sella–gnathion angles. All these changes would seem to be unusual, and certainly favourable to a reduction in overbite. These changes are not so marked in the other groups.

However, swings in the opposite direction are also seen, though not so much in the first group.

The $\frac{\text{nasion–gnathion}}{\text{sella–gnathion}}$ percentage changes do not seem significant.

Therefore the favourable factors in skeletal relations appear to be: (1) Skeletal I base; (2) Tendency for the skeletal relationships to improve.

Having investigated the occlusal, soft-tissue, and skeletal factors, the types of treatment were next investigated.

*Table VIII.*—Changes in Skeletal Measurements during the Period of Treatment in 49 Cases

| Measurement | | Overbite Reduced (27) | Overbite Unchanged (12) | Increased (10) |
|---|---|---|---|---|
| S.N̂.A.–S.N̂.B. difference | Decreased | 4 | — | — |
| | Unchanged | 23 | 11 | 10 |
| | Increased | — | 1 | — |
| Frankfort–mandibular-plane angle | Increased | 8 | 1 | 1 |
| | Unchanged | 19 | 9 | 8 |
| | Decreased | — | 2 | 1 |
| Maxillary–mandibular-plane angle | Increased | 6 | 3 | 1 |
| | Unchanged | 17 | 9 | 7 |
| | Decreased | 4 | — | 2 |
| Gonial angle | Increased | 3 | 1 | 3 |
| | Unchanged | 24 | 7 | 5 |
| | Decreased | — | 3 | 2 |
| Nasion–sella–gnathion angle | Increased | 3 | — | — |
| | Unchanged | 23 | 12 | 10 |
| | Decreased | 1 | — | — |
| $\frac{\text{Nasion–gnathion}}{\text{Sella–gnathion}}$ percentage | Increased | 5 | 2 | 6 |
| | Unchanged | 15 | 6 | 4 |
| | Decreased | 7 | 4 | — |

## TREATMENT

The treatment in the 49 cases followed through the post-retention period was investigated under the following headings: (1) Extractions; (2) Appliance therapy; (3) Anchorage; (4) Retention period; (5) Tooth movements achieved.

It was then possible to compare the different types of treatment with regard to the achievement of a reduction in incisor overbite.

**1. Extractions** (*Table IX*).—The teeth extracted during treatment were noted and compared both in maxillary and mandibular arches in the three groups. Most of the cases had symmetrical extractions, but some were asymmetrical, due either to caries or very badly positioned teeth. Where "$\frac{1}{2}$" is shown in the table this indicates an asymmetrical extraction. The numbers become very small when broken up in this way, but certain tendencies emerge, viz.:—

*a*. In the cases of increased overbite during treatment (Group III) there is a much higher proportion of mandibular extractions, and

*b*. In these cases the extractions are nearer to the anterior part of the arch.

*c*. Maxillary extractions do not vary much in the three groups.

The low number of second molars extracted may be due to the fact that this results in a longer line of treatment quite often, and these cases may not have been completed in time for this final survey.

*Table IX.*—Comparison of Extractions in 49 Treated Cases

| | | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|---|
| Mandibular | Incisor | 1 | – | 1 |
| | Canine | 1 | – | – |
| | 1st premolar | $4\frac{1}{2}$ | 2 | 7 |
| | 2nd premolar | $2\frac{1}{2}$ | $1\frac{1}{2}$ | 1 |
| | 1st molar | 3 | – | – |
| | 2nd molar | – | 1 | – |
| Maxillary | Incisor | 3 | – | – |
| | Canine | 1 | 1 | – |
| | 1st premolar | 17 | 7 | 9 |
| | 2nd premolar | – | – | – |
| | 1st molar | 2 | 1 | – |
| | 2nd molar | 1 | – | – |

*Table X.*—Comparison of Appliance Therapy in 49 Treated Cases

| Type of Appliance | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|
| Upper removable appliances (28) | 13 | 8 | 7 |
| Lower removable appliances (4) | 2 | 2 | – |
| Upper fixed appliances (14) | 12 | – | 2 |
| Lower fixed appliances (18) | 13 | 1 | 4 |
| Andresen appliances (2) | 2 | – | – |
| No appliances (7) | 2 | 3 | 2 |

**2. Appliances** (*Table X*).—Appliance therapy was assessed as either removable or fixed. The removable appliances were mainly ones with canine retractors and/or labial bows, and all had had some kind of anterior bite plane to attempt depression with or without proclination of lower incisors.

The fixed appliances were all multiband type with round arch-wires, and had been used for retraction of teeth, proclination and depression of lower incisors, depression of upper incisors, and alinement. A few had been of a Begg type and been used to attempt distal movement of

incisor apices. Also, two Andresen appliances were used.

When split into the three groups, again the numbers were very small. However, it would appear that:—

1. The first group (with reduction of overbite) had proportionally more treatment in the mandibular arch.

2. Some cases had no appliance therapy and yet 2 of these improved in overbite by themselves. (These 2 cases without appliance therapy had been ones with maxillary overcrowding where extractions were carried out but no appliances used.)

The number of cases which had mandibular extractions but no appliances in this arch, although sometimes having upper appliances, was examined and the following results found: (1) Group I, nil; (2) Group II, 1; (3) Group III, 5.

Again, the numbers are very small, but may indicate a tendency for the overbite to be increased if mandibular extractions are carried out in Class II, division 2 cases, but no appliances used.

**3. Anchorage** (*Table XI*).—It was noted whether intra- or inter-maxillary traction or extra-oral traction or a combination of these were used. The results do not appear to be significant in the three groups, except that more inter-maxillary was used in the first group. Intra-maxillary was not used in the mandibular arch because the danger of collapse or over-retroclination of labial segment was realized.

Very few cases had extra-oral traction compared with those now under treatment.

**4. Retention Period** (*Table XII*).—This was checked in each case and found to vary from none at all to three years.

The retention was by removable appliances, often both upper and lower. Where no lower appliance was used, the upper appliance had a bite-plane anteriorly to maintain the lower incisors. In two cases monoblocs were used.

*Table XI.*—Comparison of Anchorage in 49 Cases

| Type of Anchorage | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|
| Intra-maxillary only in maxillary arch (20) | 10 | 5 | 5 |
| Intra-maxillary only in mandibular arch (0) | — | – | – |
| Inter-maxillary (19) | 14 | 1 | 4 |
| Extra-oral (reinforcing intra- and inter-) (3) | 3 | – | – |

The cases had all been out of retention at least six months when seen.

The time of retention includes full-time and half-time wearing.

On the whole, it appears that long periods of retention may be beneficial to reduction in overbite. The one case of three years' retention where no alteration in overbite was achieved was found to be an extreme case.

*Table XII.*—Comparison of Retention Periods in 49 Cases

| Retention Period | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|
| None | 2 | 3 | 2 |
| 6 months | 1 | 4 | 4 |
| 12 months | 20 | 4 | 3 |
| 18 months | 2 | – | – |
| 2 years | 2 | – | 1 |
| 3 years | — | 1 | – |

**5. Tooth Movements Achieved** (*Table XIII*).—Actual tooth movements achieved and maintained into the post-retention period were examined clinically and on lateral skull

radiographs. Owing to difficulties of finding fixed points on lateral skull radiographs some of the movements, e.g., depression and apical movement, were extremely hard to confirm.

The angulations of maxillary incisors were checked first. In the first group, 4 cases had maintained proclination, but these may have been due to distal movement of apices rather than labial movement of crowns. In the other two groups quite a large proportion had a sustained slight proclination.

The mandibular incisors in the first group show a high percentage of sustained proclination, although the other two groups also show some proclination.

Quite large percentages of all the groups show a further retroclination of both upper and lower incisors.

Almost half of the maxillary incisors in the first group remained unchanged.

There appeared to be more relative depression of lower incisors in the first group.

Depression of upper incisors seemed to appear clinically, but could not be proved in many cases on lateral skull radiographs.

*Table XIII.*—Comparison of Tooth Movements in 49 Cases

| Tooth Movement | Overbite Reduced (27) | Overbite Unchanged (12) | Overbite Increased (10) |
|---|---|---|---|
| Proclination of maxillary incisors | 4 | 4 | 3 |
| Proclination of mandibular incisors | 20 | 4 | 4 |
| Retroclination of maxillary incisors | 12 | 5 | 6 |
| Retroclination of mandibular incisors | 6 | 6 | 7 |
| Maxillary incisors unchanged | 1 | 1 | 1 |
| Mandibular incisors unchanged | 1 | 1 | – |
| Distal movement of maxillary incisor apices | 4 | – | 1 |
| Depression of mandibular incisors | 23 | 2 | 1 |
| Depression of maxillary incisors | 1 | – | – |

## DISCUSSION

From all the factors investigated it was seen that the following may be favourable in reduction of overbite.

**1. At the Time of Diagnosis.**—

*a. Skeletal Class I (or mild II).*—No other skeletal factor appeared to be favourable at this stage.

*b. Occlusal.*—Crowding as opposed to spacing; No excessive post-normality of buccal occlusion; Overbite not severe to start with.

*c. Soft Tissues.*—Normal; Habits and tongue-thrusting seemed beneficial.

**2. Treatment.**—

*a. Extractions.*—These should be avoided in the anterior part of the mandibular buccal segments.

*b. Appliances.*—Appliance therapy should be used to procline and depress lower incisors and must be used to close lower spacing if extractions are carried out.

*c. Retention.*—Long periods of retention seem advisable, especially when growth is still proceeding.

*d. Tooth Movements.*—Proclination and depression of lower incisors with attempts to establish incisal contact seems necessary for sustained reduction.

**3. During Period of Treatment.**—Some cases improved, therefore it is possible that slight skeletal alterations which may be favourable might occur. These have not been proved and cannot be predicted, but may be related to alterations in occlusion or in general growth

and development. Long periods of retention after treatment may allow the effects of these factors to be seen.

**4. Factors at the End of Treatment.—**

1. Established occlusion. Incisal contact and occlusion in muscle balance seem essential.

2. Normal soft tissues will maintain a balanced occlusion.

3. Growth may not be complete and further changes may be expected.

The case of P. C. was compared with these findings and it was seen that in his case he had very few favourable factors to start with, except a mild Skeletal II base and normal soft tissues.

However, during treatment, mandibular spaces were closed, the incisors proclined and depressed, and an incisal contact achieved.

He showed slight skeletal changes and post-treatment alterations in occlusion which were allowed to settle favourably during the long retention period.

## CONCLUSION

This paper has been an attempt to show some factors concerned with the reduction of excessive incisor overbite in Class II, division 2 cases.

The number of cases has proved to be too small to show any significant facts.

The methods of recording soft tissues is believed to be unsatisfactory as they cannot be checked in the original state.

The lateral skull radiographs have some inaccuracies which prevent measurements to anything less than $\pm 2^{\circ}$ and slight variations render linear measurements impossible. Also the lack of fixed points makes the assessment of tooth movement difficult.

Even the models, divorced from their surroundings, cannot always be compared completely with the final result.

However, certain trends seem to emerge which may be useful in further studies in this field and it is obvious that many other factors are present as yet unknown, or at least unrecorded, and difficult to measure.

**Acknowledgements.**—I should like to express my thanks to the Consultants and Members of Staff at the Royal Dental Hospital and the Hospital for Sick Children for their permission to examine their cases and for helpful criticism. I should also like to thank the Photographic Department at the Royal Dental Hospital for the photographs.

## *DISCUSSION*

*The Chairman* thanked Miss Ridley and said that this type of analysis of treated cases was of vital importance and he hoped that other members would follow her example in the future. It was essentially a long-term research and meant not only meticulous notetaking and recording and collecting material very carefully from the very beginning, but also remaining long enough in the same place, not only to see the treatment through but also to see the cases when they were out of retention.

He then called on Mr. Hovell to open the discussion.

*Mr. J. H. Hovell* said that he was very pleased to be able to open the discussion on Miss Ridley's paper, because it commenced to answer criticism one heard from overseas—and he included Ireland in that category—regarding English research work. It had been suggested that they said a lot of things without ever having shown them.

At the Royal Dental Hospital they were now building up a large stock of records, both lateral skulls and models, of treated cases, which were a very valuable source of material for analytical research work of that nature, of which there was no doubt too little was being done at the moment in this country. It was obvious, when one saw the paper, why there was too little. It was no job for anyone who was afraid of hard work.

As well as demonstrating little changes during treatment and retention in those cases, the measurements presented also demonstrated quite incidentally the overall stability of the facial skeletal pattern during the growth period, the comparatively small changes which were in fact taking place, and how even those small changes could affect the issue.

Miss Ridley's statement that the Class II, division 2 malocclusion or classification of Angle comprised many different types of cases was undoubtedly true. Those different types had different aetiologies in all probability. For example, that of the same dental malocclusion on a Class II and on a Class III dental base.

He did not like Miss Ridley's use of the term "lip posture". He preferred to think of soft-tissue patterning of the lips as comprising three features: first, morphological features; secondly, patterns of activity during swallowing; and thirdly, habit activities.

Morphological features, into which fell competent and incompetent lips, were not dependent upon musculature activity, and could not therefore readily be called postural. Habit activities, however, were produced by active musculature and were postural. A distinction ought to be made there, because it was not just a matter of nomenclature; it was a matter of what was happening

in those cases. This is unlike the term "incompetent lips", to which some members of the Society objected and to which there was no reasonable alternative. Since by definition all orthodontists should be aware of what that term meant when used by fellow orthodontists, its use was justifiable, and he could think of no better term to replace it.

Certain findings in the paper caused him some surprise.

As many as 10 cases had incomplete overbite due to tongue thrust; he would not have expected so high a percentage of tongue thrust as that. Moreover, none of the tongue thrusts had a lisp, apparently. That again seemed contradictory. It would seem to him that a tongue thrust in a Class II, division 2 malocclusion must be an innate activity and not a habit activity, and yet, in his experience, it was very rare for innate tongue thrusts to have no speech defect. Perhaps Miss Ridley could shed more light on that?

He would like to see different types of cases analysed —that was a job for someone else—to see whether the same figures came out.

Another surprising finding to him was the high percentage of increased intra-occlusal clearances and distal paths of closure. Was it possible that a number of those cases were not true distal paths of closure, but were habit activities of a downward and forward resting posture with incisal contact? Those were very common in Class II, division 2 cases, and true distal paths of closure with increased intra-occlusal clearance very rare. It was very much dependent on clinical estimation, and it was very difficult, as Miss Ridley said, to assess and make foolproof or unassailable statements on it. The fact that the number of retrusive paths of closure, increased intra-occlusal clearances, and incompetent lips habitually together all increased at the end of treatment would seem to bear out that point of view, that they might be habit activities, as everyone knew that those habit activities were frequently associated with habit sealing of incompetent lips and increased markedly during that age period.

Could Miss Ridley explain the better prognosis for reduction of overbite in cases with crowding of the lower buccal segments? Did she think it was because, in those cases, loss of continuity in the lower buccal segments early on during the development of the occlusion had permitted the lower labial segment to tilt lingually, and that that could therefore be proclined slightly during treatment if it was buttressed forward by buccal segments in good alinement? Miss Ridley had mentioned the effect of closing spaces and bringing the upper space up against the labial segment. The question of forward buttressing was one on which some more information was needed. He was sure it occurred, as could be seen in cases of asymmetrical loss of buccal segment support. He felt that, in adulthood, the labial segment frequently tended to crumple up in those cases and drop back to its normal position in soft-tissue balance, thus producing a late relapse—the sort of case the periodontist was more likely to see than anyone else. In other words, one was wiser not to rely in treatment planning upon buccal support for labial segments. He hoped that Miss Ridley would be able to follow up those cases for a sufficient period of time to check upon that. Has Miss Ridley related the cases which improved to the possibility that the incisor position originally produced by the soft-tissue patterning would have placed the lower incisal edge in unstable relationship to the palatal surface of the upper incisor? In other words, treatment had just enabled the lower incisors in some cases to slip labially from that unstable position instead of palatally. He referred to Backlund's work in that respect.

*Mr. H. L. Leech* said that he was very interested in the Class II, division 2 cases. He had been using the Begg multi-band appliance for a good many years. In those cases where he had attempted to reduce the overbite by moving the apices of the upper incisors palatally, he had been disappointed. He was coming to the conclusion that this type of treatment was doomed to relapse. He wanted to know if Miss Ridley had had the same experience. He found that they had to be retained for a very long time and he was not sure that a removable appliance was sufficient. He thought that the permanent reduction of incisor overbite was very nearly impossible in those cases. He found that in some cases the relapse did not necessarily occur soon after the removal of retention, but, in one case particularly, which he was hoping to show next year, a little relapse occurred after one year but a great deal during the next three years, of the incisor overbite. He made a plea that Miss Ridley should follow up cases for some years afterwards to see if that occurred.

He was interested in the increase in the angle between the Frankfort plane and the mandibular plane during treatment and wondered if Miss Ridley related that in any way to the inter-occlusal clearance before and after treatment.

*Mr. E. K. Breakspear* said that during the last two or three years he had formed an empirical policy of trying to separate out what might be called the natural and artificial factors in such a case. For example, if there was early loss of teeth in the lower arch, he regarded that as something additional. He felt that, in those cases, he could restore the lower arch to a certain extent, thereby returning it to the condition in which it would have been originally, had there been no extraction. Beyond that point, he felt very hesitant to go. Would Miss Ridley agree that that was a sound type of approach in the initial stages?

His second question was, Had she noticed any change due to psychological causes? He noticed 77 per cent of cases had lip contraction and he felt that, in some cases, that was affected by the child's outlook. In one or two cases he had in mind it seemed to happen that the child grew older and got a better outlook on life—he might not—but if he did, then there was a certain relaxation of general tension. In those cases, he had found that he had been able to get some improvement in the overbite which, apart from psychological change, he would not have expected. He would like Miss Ridley's comments on that.

*Mr. G. C. Dickson* had two small points to raise.

Miss Ridley had said that she did not think it was possible to measure angles accurately to nearer than 3°. He understood that 3° was the change in the ANB angle that she regarded as significant, and felt that the degree of change which could be regarded as significant depended very much on the particular angle that was being measured. He would have thought that the angle ANB could be measured accurately to 1° on any good lateral skull film and that a change of 2°, which was shown in the first case she had recorded, was in fact significant. It was 2° in 7° which, if his arithmetic was correct, worked out at something between 25 and 30 per cent change.

Miss Ridley had said that she could not suggest any method of knowing in advance whether or not favourable

growth change could be predicted. He wanted to point out the work of Ricketts in that field and suggested that if one could get one's cases a year or two before starting active treatment, some idea of the growth trend could be made—if one was able to get a lateral skull 2 years before treatment commenced so that the change could be seen on a subsequent film; in other words, one was treating on a dynamic and not a static picture.

*Mr. W. A. Nicol* said that out of all the great variety of features that were difficult to assess, one feature apparently was common to all Class II, division 2 cases, and that was the high lip line in relation to the central incisor teeth. That was particularly gratifying to him. When it came to treating Class II, division 2 cases and assessing the results of treatment, Miss Ridley said that she thought the upper incisors were sometimes depressed but that that was impossible to measure or to assess on analysis. He suggested that it might be possible to measure some difference in the relation of the incisors after treatment to the lip line, and, as that was a constant feature of Class II, division 2, it might be of some value.

*Mr. C. D. Parker*: Did Miss Ridley think that the behaviour of the maxillary–mandibular-plane angle during treatment had any influence upon the re-establishment of the deep overbite? In other words, were those cases in which the maxillary–mandibular-plane angle opened during treatment more likely to relapse?

*Mr. J. K. Wilkie* said that he had the impression that in some of the Class II, division 2 cases, a patient would swallow with the incisor teeth in contact and the cheek teeth apart. Had Miss Ridley noted that?

*Mr. P. J. Holloway* asked Miss Ridley if she made any observations on the condition of the periodontal tissues around the anterior teeth in those cases?

*Miss Ridley*, in reply, first of all thanked the President for his remarks. She then thanked Mr. Hovell for his remarks and said that she was very pleased that he had given up his time to open the discussion on her paper.

Mr. Hovell had, she noticed, disapproved of the term, or her misuse of the term, "lip posture". Of course, he was quite right, as usual! She was attempting to express competence and habitual posture at the same time, as that was more convenient from the point of view of clinical assessment.

On the question of tongue thrusts, those mentioned were not severe and perhaps should have been called "forward position of the tongue during swallowing". In most of the cases, there was no anterior open bite present. She was not an expert on speech at all, but she would have thought that a lisp was more often associated with an anterior open bite.

On the question of whether the thrusts were endogenous or not, she was not very good at determining this at the first assessment. However, if they disappeared, she put them down as "habitual" but if they persisted she called them "endogenous"!

With regard to the point about intra-occlusal clearance and mandibular posture, she thought the answer was that the records were incomplete on these aspects and in the original assessments made several years ago they may have confused a forward posture with a distal path of closure. That was a misrepresentation of the term and would explain the unexpected results. She would not attach too much importance to any of those findings because she was not very certain of them herself.

On the question of crowded buccal segments, the main point she wanted to stress was not to leave them crowded but to attempt to close the spacing. She was very interested in what Mr. Hovell said about cases relapsing later on in life, even if one had managed to hold the labial segments forward by closing the buccal spacing. She did not think any work had been done on following through cases into the adult state. One or two of her patients were around 21 years and 22 years, but she thought that the relapse Mr. Hovell talked about would occur nearer to 30 years of age, with a general deterioration of the periodontal condition, and often following on some loss of teeth due to caries.

She thought that the improvement in the cases was mainly due to a better incisal contact, the lower incisors going incisally rather than palatally. She thought it was important to try to achieve good contact with maxillary incisors, but felt that the movement should be of the mandibular incisors and not the maxillary. If possible, leave the maxillary incisors alone, because they were in muscle balance, and if an attempt were made to move them, they would probably relapse back again. Instead, an attempt should be made to do most of the alterations in the mandibular teeth.

She thanked Mr. Leech for his remarks; it was Mr. Leech who had taught her how to use Begg arches and he knew more about them than she did. She had used a Begg arch on P. C. and the incisors had appeared to relapse back again. The final result depended on the severity of the case, which was probably the main point, and there were some cases in which, whatever treatment was used, a good incisal relationship would not be obtained.

With regard to the relationship between alteration in Frankfort–mandibular-plane angle and intra-occlusal clearance, there again she wished that she could have recorded the original intra-occlusal clearance. The only note she had was that it was slightly increased before treatment and was normal after treatment and that sort of recording was not very reliable. She wished she had had better records before starting treatment because she could not really relate a difference to the increase of the Frankfort–mandibular-plane angle.

Regarding Mr. Breakspear's question, his appeared a very sound approach to her. The point about correcting the effects of early loss was very good: and then going on to other factors later, as they arose.

She was very interested in what he had said about the psychological aspect. She had not gone into that because she really did not know anything about it, and one could not investigate all the different aspects. But she personally felt—although she had no scientific backing for it—that many of the Class II, division 2 cases had a peculiar psychological make-up. They tended to be rather nervous and it was very interesting that Mr. Breakspear should have noticed this also.

She thanked Mr. Tulley for his remarks, but did not really think that he had asked her a question which called for an answer.

In reply to Mr. Dickson, she said that *she* could not measure to that degree of accuracy. She had taken some lateral skull radiographs herself and she knew how much the ear-plug moved, and also that the head could move as it was not held rigidly. Also some of these radiographs were taken on different machines. She had traced some of them again and found a slight variation. Some people might be able to achieve greater accuracy, but she had thought that she ought to say that for her, personally, $\pm 2^{\circ}$ was really as accurate as she could get. Mr. Dickson had mentioned the percentage of change; she had not

really meant that a difference of 2° was not statistically significant, but that due to her error of ±2° an alteration of more than this was needed to show a definite change.

The idea of Ricketts, i.e., of taking lateral skulls for a year or two, before starting treatment was a good one and it would be very helpful if that could be done in all cases.

She thanked Mr. Nicol for his remarks which, in the case of measuring the lip line, would have been useful. However, the distance would have to measured exactly before treatment, and she had not done that. She just assessed whether it was high or low. To be able to tell whether they had actually been depressed, it would have to be measured exactly.

The only note that she had in reply to Mr. Parker was "No, they didn't", and she hoped that answered his question!

Mr. Wilkie had mentioned swallowing with the incisor teeth together but cheek teeth apart. She thought that this type would be included in what she was calling the "teeth-apart swallow".

In reply to Mr. Holloway, she said that there were 36 cases of very deep overbite and all those certainly were associated with some stripping of the gingivæ. That was the only note she had made about gingivæ.

# RETRACTION OF UPPER BUCCAL SEGMENTS USING REMOVABLE APPLIANCES

By **VINCENT B. MORRIS**, B.D.S. (N.U.I.), F.D.S., D.Orth. R.C.S. (Eng.)
*Senior Registrar, Orthodontic Department, Royal Dental Hospital, London*

RETRACTION of upper buccal segments is required in about 7 per cent of all patients attending an orthodontic department for treatment. The types of maloeclusion which require this form of treatment are varied, and the following are typical examples, all having the common factor that half a unit or less distal movement is required:—

1. Class II, division 1 maloeclusions, in which there is not more than half a unit post-normality and an increased overjet of approximately 4–5 mm., the lower arch being acceptable.

2. Some Class II, division 2 cases.

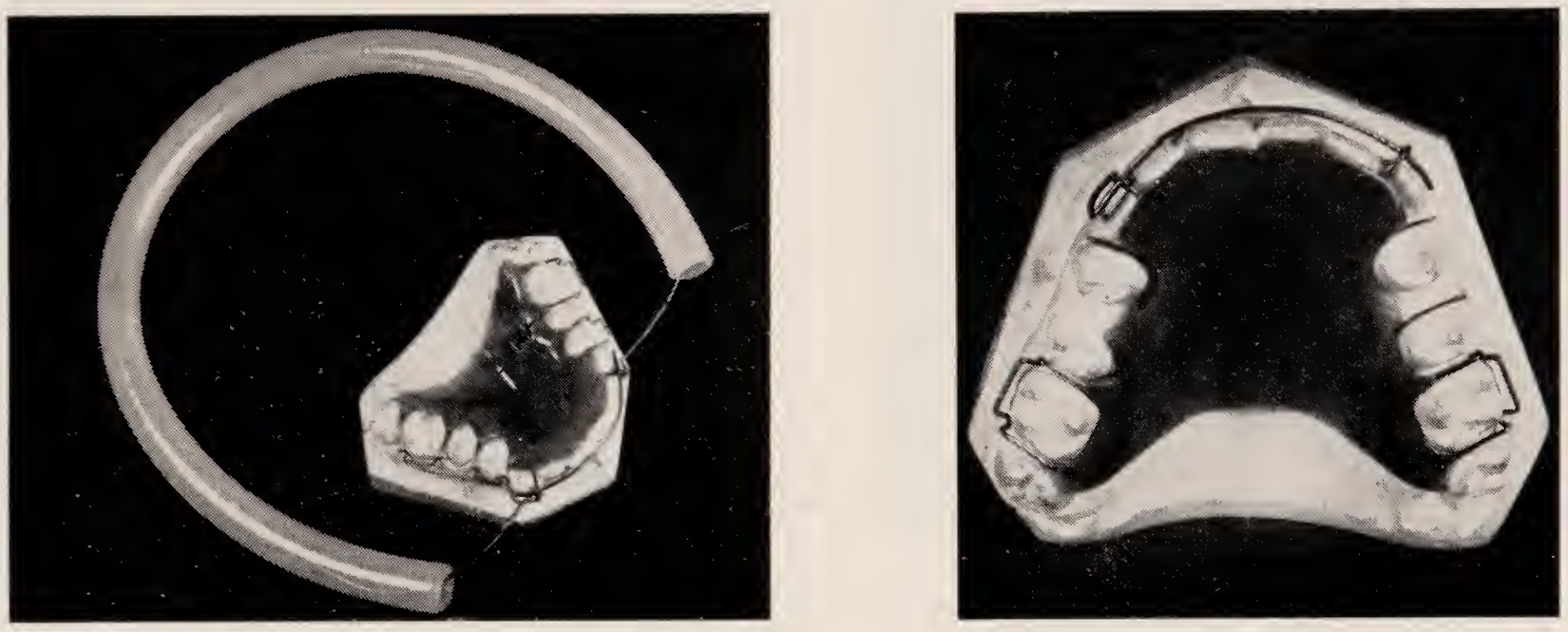


*Fig.* 1.—Shows the appliances used, which have been described previously.

*Fig.* 2.—Shows the buccal occlusion prior to treatment.

3. Cases where upper buccal segments have drifted forward due to either buccal or palatal misplacement of canines.

4. Class III cases with some degree of crowding in the upper buccal segments.

Extraction of upper second molars is frequently necessary in these cases because a shortness of dental base would not permit the

Demonstration given at the meeting held on May 9, 1960.

placing of all the cheek teeth in acceptable functional positions.

**Favourable Factors in Treatment Planning.**—The following favourable factors should be ascertained before planning treatment:—

1. Adequate length of upper buccal segment apical base.

may be needed. The first appliance is used to retract $\underline{76|67}$ and the second to retract $\underline{543|345}$.

**Stage I.**—Twin screw plate supported by extra-oral traction.—

*Design.*—Retention is vital, as insecurely inserted appliances do not work and tend to slip off the teeth on activation. Thus Adams

*Fig.* 3.—Shows the buccal occlusion when $\underline{76|67}$ were retracted. Note the amount $\underline{5|5}$ have followed distally although not included in the appliance.

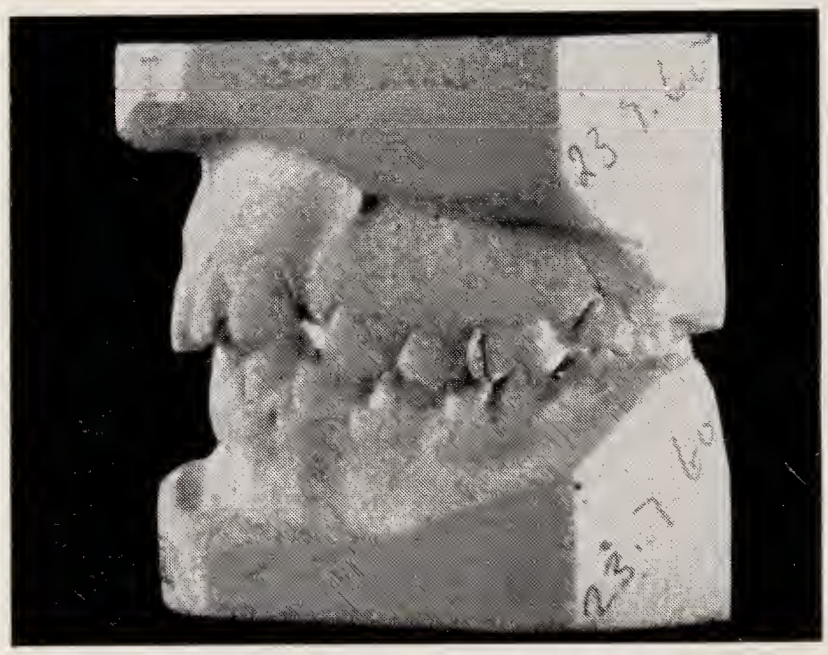


*Fig.* 4.—Shows the buccal occlusion with $\underline{7654|4567}$ fully retracted. Ample space has been provided for $\underline{3|3}$. Note that $\underline{|3}$ has improved spontaneously.

2. Mesial inclination of $\underline{6|6}$.

3. No radiographic evidence of "stacking" of $\underline{876|678}$.

4. Shallow cusps and fossæ.

## APPLIANCES

Generally, only two appliances are required, except where canines are in unfavourable positions, when a third appliance to aline these

Cribs on $\underline{64|46}$ are desirable. Also a strong 0·8 mm. low labial bow of the crossover type is placed slightly above the incisal edge of the incisors. This labial bow aids retention, provides additional anchorage, and is the means of attaching the extra-oral appliance.

*Screws.*—Glenross screws are used and are placed so that, on opening, the distal part of the plate moves in a distal and outward

direction along the line of the alveolar ridge. Incorrect placing may lead to failure of the appliance by pushing the teeth off the alveolar ridge, thereby throwing heavy strain on the anchorage. To decrease further the anchorage problem the screws are placed just anterior to 6|6, so that 76|67 (or 6|6 only in extraction cases) are moved.

Note that 5|5 are not pushed distally with the first appliance. However, they generally drift about three-quarters of the distance travelled by 6|6. The appliance is accordingly trimmed to permit 5|5 to move.

The screws are turned once per week on both sides. This gives 4 mm. movement in 4 months.

A bite platform, as small as is required, is used in all stages to avoid cuspal interference, especially if 7|7 are extracted, as then $\overline{7|7}$ may over-erupt.

**Stage II.**—When 76|67 are retracted (a little more than the exact amount is desirable), a second appliance is provided. This has the following design:—

1. Adams Cribs 6|6.
2. 0·8 mm. crossover labial bow.
3. 0·5 mm. finger springs to move 543|345 distally.
4. Slight bite platform.

The finger springs are activated in pairs; firstly 5|5 are activated simultaneously. These teeth are usually retracted in one month as they have already moved most of the distance required. Then 4|4 are retracted and finally 3|3, if required. Extra-oral anchorage is used throughout these movements.

**Extra-oral Support.**—All types may be used, but the type presented is generally employed because of its simplicity, ease of manipulation and construction, and its efficiency. It consists of:—

1. A length of polythene tubing of 1 cm. bore, measured to the patient's requirements.
2. Two pieces of 1 mm. S.S. wire, bent at both ends to hold the rubber band and for attachment to the appliance (*see Fig.* 1).
3. One No. 32 elastic band.

To receive the extra-oral support a U-bend is placed in the crossover labial bow just before it crosses over the mesial contact point of the upper canine into the acrylic.

**Wearing of Appliances.**—This should be continuous, especially during meals, to avoid cuspal interference; the extra-oral support being worn at night only.

*Figs.* 2–4 illustrate a case treated by the method described above:—

P. J., aged 13, attended with 3| in the palate and |3 buccally placed with forward position of the upper buccal segments. 8|8 were missing. The lower arch was satisfactory.

**Acknowledgements.**—I wish to record my thanks to Mr. D. P. Walther, Director of the Orthodontic Department, Royal Dental Hospital of London, for permission to publish this case, and for his encouragement during the preparation; to the staff of the Photographic Department of the Royal Dental Hospital of London; and to Mr. E. D. McBride of the Royal Dental Hospital of London for technical assistance in preparing the models used at the demonstration.

# REPORTS OF MEETINGS

## ORDINARY MEETING, January 11

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 11, 1960, at 7.30 p.m. The President, Mr. D. P. Walther, occupied the Chair.

The Minutes of the Annual General Meeting held on Monday, December 14, 1959, were read by the Secretary and confirmed with the following alteration: "That the words, 'The size of the balance was maintained as provision for outstanding accounts' be amended to read, 'The balance was maintained against foreseeable contingencies'."

The Minutes were signed by the President as a correct record.

The Secretary reminded members of the demonstration meeting which was to take place on May 9, and added that the Council would be glad to receive other offers of demonstrations. Perhaps those who were interested would care to communicate with him by letter.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. M. A. Burley, F.D.S., D.Orth. R.C.S., Orthodontic Department, Bristol Dental Hospital, Bristol 1;

Mr. I. G. Govan, B.D.S., 29, Bridge Street, Hawick, Roxburghshire;

Mr. J. A. Hargreaves, L.D.S., Turner Dental School, Bridgeford Street, Manchester 15.

The President welcomed any visitors who might be present, and invited them to regard themselves as members for the evening.

He then gave his Presidential Address, on the subject:—

"*Some of the Causes and Effects of Malocclusion: An Analysis taken from a Random Sample of* 1000 *East Anglian Secondary Modern School Children*".

## ORDINARY MEETING, February 8

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 8, 1960, at 7.30 p.m. The President, Mr. D. P. Walther, occupied the Chair.

The Secretary (Mr. B. C. Leighton) read the Minutes of the meeting held on Monday, January 11, 1960, and they were approved as a correct record and signed.

The President: It is with the deepest regret that I have to announce the death of one of our honorary members, Dr. Lilian Lindsay. She had been a loyal member of our Society since 1922, and was President in 1938. She had the distinction of being the first woman to attain a dental qualification in Great Britain. Dr. Lindsay was President of the British Dental Association in 1946, and in the same year was honoured with the C.B.E. She was also an honorary member of both the British Dental Association and the European Orthodontic Society. There can be very few in our profession who did not know and admire her immensely. We have all lost a very distinguished colleague and friend, and I would ask you all to stand for a few moments in silence.

A brief silence was accordingly observed.

The following candidates were elected *en bloc* by a show of hands:—

Mr. J. D. Atherton, B.D.S. (L'pool), D.D.O. (Glas.), 5, St. Anne's Grove, Liverpool 17;

Miss H. E. Brearley, L.D.S. R.C.S. (Eng.), 33, Church Hill, Epping;

Mr. J. A. Crease, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), Laurelhurst, Tenterden, Kent.

Mr. M. R. Hood, B.D.S. (Glas.), 27, Gordon Terrace, Ayr, Ayrshire;

Capt. W. K. Lervy (R.A.D.C.), L.D.S. R.C.S. (Eng.), 83, Crookston Road, Eltham Park, London, S.E.

Dr. G. M. Ardran and Dr. F. H. Kemp then gave their paper entitled:—

"*Biting and Mastication: A Cinéradiographic Study*".

## ORDINARY MEETING, March 14

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place,

London, W.1, on Monday, March, 14, 1960, at 7.30 p.m. The President, Mr. D. P. Walther, occupied the Chair.

The Minutes of the Ordinary Meeting held on Monday, February 8, 1960, were read by the Secretary, confirmed, and signed by the President as a correct record.

Two members whose election had been confirmed at a previous meeting were introduced to the President, and signed the attendance book.

The following candidates for election were admitted *en bloc* by show of hands:—

Miss E. A. Mason, B.D.S. (Edin.), 24, James Street, Dunfermline, Fife;

Mr. T. P. G. McCartney, L.D.S. (Belfast), 71, Northfield Crescent, Edinburgh 8;

Mr. Johan Ahlgren, Royal Dental School, Malmö, Sweden (Corresponding Member);

Dr. L. B. Kelsten, 111, East Northfield Road, Livingston, New Jersey, U.S.A. (Corresponding Member).

The PRESIDENT welcomed the visitors and asked them to consider themselves members for the evening and to take part in any discussion if they so desired.

The President then introduced Mr. M. L. Brenchley, who had been House Surgeon in the Dental Department for Children at Guy's Hospital, and now worked at the Eastman Dental Hospital. He was to give a Short Communication entitled:—

"*Submerged First Permanent Molars*".

THE PRESIDENT then welcomed Mrs. Russell. Everyone knew and remembered her much better as Miss Bonnar.

Most people would remember a very excellent paper Miss Bonnar had given in 1956, entitled:—

"*Aspects of the Transition from the Deciduous to the Permanent Dentition, Part I*".

This evening, she was going a stage further and giving Part II.

## DEMONSTRATION MEETING, May 9

A DEMONSTRATION MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, May 9, 1960, at 7.30 p.m. The President, Mr. D. P. Walther, was in the Chair.

The Minutes of the Ordinary Meeting held on Monday, March 14, were read by the Secretary, confirmed, and signed by the President.

The PRESIDENT announced that the Council had considered a proposal that a prize should be awarded annually for the best paper submitted on orthodontics or an allied subject. Further details of the proposal would be circulated to members in due course.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. A. Golden, B.D.S., H.D.D., 16, Dunstan Road, London, N.W.11;

Mr. J. K. Luffingham, B.D.S. (Lond.), D.Orth. R.C.S., 48, Parkstone Avenue, Hornchurch, Essex.

The PRESIDENT declared the meeting open, and proposed a vote of thanks in advance to the demonstrators.

The following demonstrations were then given: Mr. C. P. Briggs: "*The Round-Wire Multiband Appliance*". Mr. P. H. Burke: "*Some Orthodontic Springs*". Mr. A. G. Huddart and Mr. M. F. Scott: "*Common Faults with Removable Appliances*". Mr. B. C. Leighton: "*Serial Models Illustrating some Spontaneous Changes in the Deciduous Dentition*". Mr. R. Marx: "*Various Types of Extra-oral Anchorage Appliances*". Mr. V. B. Morris: "*Retraction of Upper Buccal Segments using Removable Appliances*". Mr. J. S. Rose and Mr. R. J. Sharland: "*Cases Treated by Extraction of Permanent Canines*". Mr. J. W. Softley: "*A Coil Spring Retractor for Removable Appliances*". Mr. J. C. Stephenson: "*Simple Fixed–removable Appliances for Canine and Premolar Alinement*". Mr. G. H. Steel: "*A Daylight Tracing Box*".

## ORDINARY MEETING, October 10

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, October 10, 1960, at 7.30 p.m. The President, Mr. D. P. Walther, occupied the Chair.

The Minutes of the Ordinary Meeting of the Society held on May 9, 1960, were read by the Secretary, confirmed, and signed by the President as a correct record.

The following candidates for election were admitted *en bloc* by show of hands:—

Miss M. Connors, B.D.S., F.D.S. R.C.S. (Eng.), D.Orth. R.C.S., Royal Victoria Hospital, Boscombe, Bournemouth;

Mr. T. D. Foster, L.D.S., B.D.S. (Birm.), F.D.S., D.Orth. R.C.S. (Eng.), Orthodontic Department, Birmingham Dental Hospital, 53, Barwick Street, Birmingham 3;

Mr. D. M. Menezes, L.D.S. R.C.S. (Edin.), L.D.S. (B'bay), Orthodontic Department, Dental Hospital, 53, Barwick Street, Birmingham 3;

Mr. V. B. Morris, B.D.S. (N.U.I.), F.D.S. R.C.S. (Eng.), 3, St. John's Wood Road, London, N.W.8;

Mr. H. A. Woodward, L.D.S. R.C.S. (Eng.), 25, East Street, Havant, Hampshire.

The PRESIDENT said that Miss Clinch, who was one of the stalwarts of the Society, was going to give a short communication entitled:—

"*Three Cases showing Marked Increase in Malocclusion in the Maxillary Incisor Region*".

MR. E. K. BREAKSPEAR then delivered his paper entitled:—

"*Further Observations on Early Loss of Deciduous Molars*".

## ORDINARY MEETING, November 14

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, November 14, 1960, at 7.30 p.m. The President, Mr. D. P. Walther, occupied the Chair.

The Minutes of the Ordinary Meeting held on Monday, October 10, 1960, were read by the Secretary, confirmed, and signed by the President as a correct record.

The SECRETARY announced that he had been asked by the Council to let Members know that plans which had originally been made to hold the Country Meeting in Birmingham next year had had to be changed in order to hold the Meeting outside vacation time. It was hoped that the Meeting would now be held in Bournemouth on Friday, 5, and Saturday, 6 May, 1961. Members were advised to book with hotels early, and a list of suitable hotels would be included in the December agenda. Those whose election had been confirmed at a previous Meeting were introduced to the President and signed the attendance book.

The following candidates for election were admitted *en bloc* by a show of hands:—

Mr. H. D. P. Hughes, L.D.S. (L'pool), 17, Billing Road, Northampton;

Mrs. A. Chohayeb, B.Ch.D. (Alexandria), 332, Hor'eya St., Sidi Jaber, Alexandria, Egypt (Corresponding Member);

Mr. B. C. Crisp, M.D.S. (Adelaide), 217, North Tee, Adelaide, South Australia (Corresponding Member).

The PRESIDENT welcomed any visitors who might be present. He invited them to regard themselves as members for the evening, and to take part in any discussion which might follow the paper.

They now came, he said, to their lecture of the year—the Fourteenth Northcroft Memorial Lecture. The Lectures had been inaugurated in memory of the late Mr. George Northcroft, whom they looked upon as the Founder of the Society. George Northcroft was President of the Society in 1909 and again in 1929. The first of the Memorial Lectures was given by Professor Harris in 1947, and on that occasion the Society had been honoured by the presence of Mr. J. H. Badcock, who had been the Society's first President in 1908.

On this occasion the Society was greatly honoured by the presence of Mr. George Northcroft, the son of the great man, and in fact there was a series of the latter's record models in the Museum.

Who better could the Society possibly choose to give that lecture than its own Mr. Rix? He was so well known that he needed no introduction, a fact which was testified by the number of people present.

Mr. R. E. RIX presented his paper on:—

"*Some Problems for Consideration*".

## ANNUAL GENERAL MEETING, December 12

THE ANNUAL GENERAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, December 12, at 7 p.m. The retiring President, Mr. D. P. Walther, occupied the Chair for

the first part of the proceedings, and the incoming President, Mr. S. Granger McCallin, after his induction.

**Minutes.**—The Minutes of the Ordinary Meeting held on Monday, November 14, 1960, were read, confirmed, and signed.

**Election of Officers and Councillors.**—The PRESIDENT said that there were no other nominations and he had therefore to announce that the officers and councillors for 1961 nominated by the Council, as printed on the agenda paper, were duly elected.

**Election of two Auditors.**—On the motion of Mr. J. ROSE, seconded by Mr. H. L. LEECH, the present Auditors were re-elected.

**Report of the Treasurer.**—The TREASURER (Mr. J. S. BERESFORD) presented his report, as follows:—

The Income and Expenditure Account for 1952 shows printing reserves of £500. During the following years it was apparent, from the increased volume of material to be published, and from our discussions with the printers, that printing costs were likely to increase. Accordingly the subscription for corresponding members was raised to a sum approximately equal to the calculated cost of each volume of the *Transactions*. The sum of money reserved for printing in the accounts each year was also increased, so that by 1957 £1066 were set aside in the Income and Expenditure Account for printing reserves and for the cost of extra pages in the *Dental Practitioner*. I began to wonder if I had been over-cautious, and the reserves were reduced in 1958, while in 1959 a sum of £300 was written back from printing reserves. This was no sooner done than the bills began to come in. For instance, the short fall account for five years had to be paid in one sum and the 1958 *Transactions* at £805 proved to be £205 more than reserved. It is clear, therefore, that we must continue to carry in the Income and Expenditure Account a large sum for the printing of the *Transactions* and the pages in the *Dental Practitioner*.

Members will know that when the *Dental Practitioner* is printed some hundreds of extra pages are also printed and laid aside to be bound later as the *Transactions*. The issue is further complicated by our financial obligations regarding the printing of the *Dental Practitioner* itself, such as the short fall account agreement, so that it is difficult, or even impossible, to say with absolute accuracy how much of our printing bill is for the *Dental Practitioner* and how much for the *Transactions*. We cannot print the *Transactions* without first having the *Dental Practitioner* printed.

As reference has been made to 1952, Members might like to know that in that year the subscription income was approximately £1000, and since then it has increased to nearly £1500 annually.

I continue to be grateful to the Honorary Librarian, Mr. Gordon Taylor, for moneys received from the sale of *Transactions*.

From the Balance Sheet members will note the sale of 3 per cent Defence Bonds and the purchase of 5 per cent Defence Bonds, 3 per cent Funding Stock, and further National Savings Certificates.

On the motion of the TREASURER, seconded by Mr. H. L. LEECH, the report was *received*.

There was no discussion and a motion by the PRESIDENT from the Chair that the report be adopted was *carried*.

**Report of the Secretary.**—The SECRETARY (Mr. B. C. LEIGHTON) presented his report, as follows:—

I have to report that during the year since the last ANNUAL GENERAL MEETING, the Society has continued to flourish. Seven meetings have been held with an average attendance of 98. As the European Orthodontic Society was to hold a meeting in Belfast during the summer, it was felt by the Council that a Demonstration Meeting should be held in London instead of a Country Meeting.

The membership of the Society has continued to increase and is now approaching 500. Twenty-two new members have been elected during the year and 16 have been lost through resignation or death, including that of one of our Honorary Members, Dr. Lilian Lindsay. The membership now stands at 486.

I have to announce the decision of the Council to introduce an award for an essay on Orthodontics, to be called the "Chapman Prize". The regulations of this were circulated

with the October agendas. It is hoped that entries will be received for 1961. Application forms may be obtained from the Secretary, and entries should be received between 1st and 31st May.

On the motion of Mr. LEIGHTON, seconded by Mr. K. E. PRINGLE, the report was *received.*

On the motion of the PRESIDENT, the report was *adopted.*

**Report of the Librarian.**—The LIBRARIAN (Mr. A. G. TAYLOR) presented his report, as follows:—

The two following books have been purchased for the library:—D. P. Walther, *Orthodontic Notes*; and W. J. Tulley and A. C. Campbell, *A Manual of Practical Orthodontics.*

It is an unalloyed pleasure to have books written by members of this Society.

We are also indebted to Mr. John Heath sen., for a reprint of his paper, "*Three Variants of the Screw X Plate for Treating Prominent Upper Front Teeth*".

Arrangements have been made for obtaining the *American Journal of Orthodontics* on an exchange basis. The exchange of our own *Transactions* for other publications is now quite extensive and covers the *Transactions* of French and Spanish Orthodontic Societies, the British Society of Periodontology, *The Rumanian Dental Quarterly*, and *Dental Abstracts.* If the library were not bursting at the seams the exchange could be extended to many more countries, including Russia and China, and applications continue to arrive.

Besides the Transactions and Journals we receive by exchange the Society subscribes to the *Angle Orthodontist* and buys the *Transactions of the European Orthodontic Society* as well as receiving more material as gifts.

I am passing the library on to Mr. Donald Smith, who, I am sure, will do vastly better than I have done.

On the motion of Mr. TAYLOR, seconded by Miss L. CLINCH, the report was *received.*

Mr. E. K. BREAKSPEAR said that he had no questions, and he might be "jumping the gun" but he wanted, as an ordinary member, to pay tribute to the extraordinary, unfailing courtesy, helpfulness, and efficiency of the Library Service, ever since he could remember. He was told by Mr. Taylor that it went back at least 20 years. Mr. Taylor also said that he was always ready to supply the helpfulness, but the efficiency was largely a matter of luck, according to when he got to town. That he himself disbelieved; he had evidence otherwise. He had borrowed a good many books, some for long periods, and even if he had had a book for 12 months or more, in all the time he had known him, Mr. Taylor had never asked him to return them! He wished to express the thanks of very many members. (Applause.)

On the motion of the PRESIDENT, the report was *adopted.*

**Report of the Curator.**—The CURATOR (Miss L. M. CLINCH) presented her report, as follows:—

The Museum is still housed next door to Manson House in the Institute of Public Health, 26, Portland Place, where it can be seen between 10 a.m. and 5 p.m.

During the year the following additions were made:—

1. Models with the actual teeth inset, showing right and left maxillary first premolars with three cusps on each crown and three fused roots; presented by Miss E. M. Still.

2. Models, photographs, and lateral skull radiographs of identical twins, one whose general growth had been considerably retarded between 2 and 14 years of age by hypothyroidism, and the other who had grown normally.

3. Serial models between 6 weeks and 12 years showing postnormal occlusion of the mandibular arch (29 pairs of models in all); presented by Mr. W. Duncan.

It is hoped to have a cabinet made to hold the face masks and models presented to the Society some years ago by Dr. Northcroft; this is probably the most valuable exhibit in the Museum, and it is hoped it will then be less liable to damage and much easier to view.

The photograph album of past Presidents of the Society is complete up to 1958, except for 1953.

On the motion of Miss CLINCH, seconded by Mr. W. J. TULLEY, the report was *received.*

On the motion of the PRESIDENT, the report was *adopted*.

**Report of the Editor.**—The EDITOR (Mr. W. J. TULLEY) presented his report, as follows:—

I have to report that the *Transactions* for 1959 have been at the binders for some time and I had hoped to have them available for this meeting. I understand all the binderies in the country are exeessively busy. With regard to the material for this current year, the papers presented in Oetober should be in the January issue of the *Dental Practitioner* and all the readers of papers have been most eo-operative in letting me have their material promptly, whieh has made things much easier.

We have been fortunate in receiving offers of many interesting papers for the eoming year. I would once again eneourage all members to write up and offer as short communieations any interesting eases they may have. I am sure that teaehing sehools in their vieinity will always help them to obtain lateral skull radiographs and any other data which they may not be able to obtain themselves, in order to make these presentations as interesting as possible. They should not hesitate to submit really interesting eases beeause they may not have the faeilities of a teaching sehool.

I repeat what I have said on several oceasions, that the Society is desirous of maintaining a proper balanee between the theoretieal and the praetieal aspeet of the subjeet. Members are to blame if they do not bring forward interesting material of a praetieal nature for diseussion at our meetings.

I beg to move the reeeption of this report.

On the motion of Mr. TULLEY, seeonded by Mr. P. BURKE, the report was *received*.

On the motion of the PRESIDENT, the report was *adopted*.

*Members Attending for the First Time since their Election*:—Mr. T. G. Woodward and Mr. V. B. Morris, who were attending for the first time sinee their eleetion had been eonfirmed at a previous meeting, were introdueed to the President, and signed the Obligation Book.

The President announced that that eoncluded the business of the Annual General Meeting.

Guests and visitors were then admitted.

## PRESIDENT'S VALEDICTORY ADDRESS

The retiring PRESIDENT (Mr. D. P. WALTHER) said that the time had now come when he had to vaeate the Chair, and before he did so, it was customary for him to give a brief aeeount of his stewardship. Members had heard the reports of the various offieers of the Society and he thought they would agree with him that they had had a most suceessful ycar. In faet, they had reached a record for attendanees for Mr. Rix's Northeroft Memorial Leeture.

He was delighted that the Chapman Prize has been instituted this year and he was looking forward to hearing the first paper in the very near future.

He thanked members of the Couneil for their loyal support and all their hard work during the year. Miss Clineh, as they knew, was now Senior Viee-President of the Soeiety and had passed over the Curatorship to Mr. Mills. That offiee she had held sinee 1939—in faet he thought it was even before that, exeept when she was holding higher office. He thanked her for all she had done and also for her magnifieent gift of a eabinet for the Museum. (Applause.)

Mr. Smith had sueeeeded Mr. Taylor as Librarian, as Mr. Taylor had now beeome Vice-President of the Soeiety. He had held the Librarianship sinee 1941, and he thanked him also for all those years of very loyal serviee. (Applause.)

He also wanted to say a speeial "thank you" to Mr. Tulley. Not only was he their Editor, whieh involved an unbelievable amount of hard work, but also Chairman of the Editorial Sub-Committee, whieh dealt with all their diffieult problems.

Others he wanted to eongratulate and thank were Mr. J. S. Beresford for looking after the finaneial side of the Society so suecessfully; and last but not least, Mr. Leighton, who had been an absolute tower of strength. In faet, he himself had been eompletely spoiled and spoon-fed!

Finally, he thanked all the members for his very happy year.

He then asked Mr. McCallin to come up so that he could invest him with the magnificent badge of office. He wished him a very successful year and hoped he would enjoy it as much as he himself had.

**Induction of New President.**—The PRESIDENT inducted Mr. S. G. MCCALLIN as the new President and handed over to him the chain of office.

Mr. BURKE said that his duty was the pleasant and easy one of reminding members of the debt of gratitude they owed to the Retiring President. They had been fascinated by the elegant and diplomatic way in which he had presided over the meetings, in his own quiet and inimitable manner. They were very pleased that he could devote so much time from his various farming activities to attend! (Laughter.)

To be serious, they knew he could ill spare the great amount of time he must have devoted to the Society in the last year. It was a measure of the success of that that the Society was flourishing in the various ways they had heard about that evening. He asked members to support him in proposing a most sincere vote of thanks to Mr. Walther.

The new PRESIDENT (Mr. S. GRANGER MCCALLIN) said that it was the custom for the President to say a few words and he thanked members very much for the warm welcome they had given him when he took over as their President. They had done him great honour in inviting him to act as their principal officer in the coming year. He hoped that, with the aid of the Council, who worked very hard on their behalf, he would be able to maintain the traditions of the Society, as his predecessor, and many predecessors before him, had done. They could be very proud of their heritage; the increasing size of their membership bore witness to the foundations, and the excellence of the foundations, laid down by those who had gone before.

But if the Society was to survive, they must continue to go forward, and, basically, any Society could go forward only if the ordinary membership stimulated the Council with constructive ideas and, occasionally, constructive criticism, in order that the things that went on were kept up to date.

He had been mildly disturbed that evening that the President could run through the agenda without anyone questioning the fact that the Society had made a loss, among other things. Work was carried on by the Council every year, and unless the members of the Society had something to say about the way they ran the show, he did not see how they could hope to survive. He very much hoped that members would feel free to approach him personally, or write to the Council, if they had ideas, rather than talk behind their backs about things that, in the members' view, should be altered. After all, the Chapman Prize was the direct result of a letter written by an ordinary member, making a suggestion along the lines that they had finally formally arranged things. More ideas of that kind would be welcomed.

Members would receive their programmes for next year during the coming month and he hoped they would think, as he did, that they could look forward to a good year.

As they all knew, it was planned that their Country Meeting should be held in Bournemouth. That was something of an experiment; they had not moved away from a Dental School before and it was hoped that it would stimulate a large attendance and that members would bring their wives or husbands and make quite a party of that particular meeting. He advised them to get booked up. He knew, because he had been down to Bournemouth and investigated the problem, and the hotels were beginning to fill up for that time of year.

He thanked them once again for inviting him to be their principal officer.

He wished them all a happy Christmas and said that he would be addressing them on January 9, when he presented his Presidential Address. It would be entitled "*Extra-Oral Traction in Orthodontics*".

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

# Balance Sheet and

# Income and Expenditure Account

## FOR THE YEAR ENDED SEPTEMBER 30, 1960

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FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS
22 Queen Street, London E.C.4

# The British Society for the Study of Orthodontics

## INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1960

| 1959 £ | 1959 £ | | £ s. d. | £ s. d. |
|---|---|---|---|---|
| 12 | | To *Museum Rent* .. .. .. | | 10 10 0 |
| | | ,, *Meeting Expenses:*— | | |
| | 33 | Hire of Hall .. .. .. | 54 0 0 | |
| | 65 | Refreshments .. .. | 82 16 8 | |
| | 48 | Reporting .. .. .. | 47 6 8 | |
| | 6 | Lantern and Films .. .. | 6 0 0 | |
| | 74 | (Country Meeting) .. .. | — — — | |
| | 60 | Northcroft Memorial Lecture | 26 5 0 | |
| 286 | — | | | 216 8 4 |
| | | ,, *Printing:*— | | |
| | 461 | Publications (including Transactions 1960) .. .. | 1,493 4 2 | |
| | 101 | General Printing and Stationery .. .. .. .. | 114 13 5 | |
| 562 | — | | | 1,607 17 7 |
| 3 | | ,, *Library and Journals* .. .. | | 15 0 6 |
| 52 | | ,, *Postage* .. .. .. .. | | 65 12 6 |
| 18 | | ,, *Honoraria* .. .. .. | | 23 2 0 |
| 39 | | ,, *Accountancy* .. .. .. | | 26 5 0 |
| 4 | | ,, *Insurance* .. .. .. | | 4 3 6 |
| 29 | | ,, *Sundry Expenses* .. .. | | 10 5 1 |
| 34 | | ,, *Depreciation* of Furniture and Equipment .. .. .. | | 34 4 0 |
| 981 | | ,, (Excess of Income over Expenditure for the year) .. .. | | — — — |
| £2,020 | | | | £2,013 8 6 |

| 1959 £ | 1959 £ | | £ s. d. | £ s. d. |
|---|---|---|---|---|
| | | By *Members' Subscriptions:*— | | |
| 1,395 | | 1960 Subscriptions .. .. | 1,451 19 6 | |
| 13 | | Arrears Collected .. .. | 35 15 0 | |
| 1,408 | | | | 1,487 14 6 |
| 144 | | ,, *Sale of Transactions* .. .. | | 142 7 0 |
| | | ,, *Interest Received and Accrued:*— | | |
| | 12 | Savings Certificates .. .. | — — — | |
| | 17 | 2½% Consolidated Stock .. | 17 5 4 | |
| | 20 | 4% Consolidated Stock .. | 20 0 0 | |
| | 17 | 3½% Defence Bonds .. | 9 9 4 | |
| | 19 | 5¼% Hertfordshire C.C. Stock (net) .. .. .. | 19 5 10 | |
| | 16 | 5¼% Corporation of London Stock (net) .. .. .. | 16 1 8 | |
| | — | 3% Funding Stock .. .. | 10 16 10 | |
| | — | 5% Defence Bonds .. .. | 12 6 6 | |
| | 23 | Post Office Savings Bank .. | 26 6 6 | |
| 124 | — | | | 131 12 0 |
| 44 | | ,, *Income Tax recoverable 5th April*, 1960 .. .. .. | | 22 7 6 |
| 300 | | ,, (Printing Reserves written back) | | — — — |
| — | | ,, *Excess of Expenditure over Income for the year* .. .. | | 229 7 6 |
| £2,020 | | | | £2,013 8 6 |

# The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1960

| 1959 £ | | £ s. d. | £ s. d. |
|---|---|---|---|
| | *Accumulated Fund:—* | | |
| | Balance at 1st October, 1959 .. .. | 4,641 12 9 | |
| | *Add* premium on redemption of 3½% Defence Bonds .. .. .. | 5 0 0 | |
| | | 4,646 12 9 | |
| 4,642 | *Less* Excess of Expenditure over Income for year to date .. .. .. | 229 7 6 | |
| | | | 4,417 5 3 |
| | *Creditors and Reserves:—* | | |
| 1,125 | Publications printing reserves (estimated by the Hon. Treasurer) .. .. | 1,700 0 0 | |
| 26 | Northcroft Memorial Lecture .. .. | 26 5 0 | |
| 13 | Hire of Hall .. .. .. .. | 13 10 0 | |
| 10 | Museum Rent .. .. .. .. | 9 12 6 | |
| 5 | Subscriptions in advance .. .. | 12 10 0 | |
| 2 | Hon. Secretary Petty Cash Account .. | 4 6 8 | |
| 26 | Accountancy .. .. .. .. | 26 5 0 | |
| 12 | (Sundry Expenses) .. .. .. | — — — | |
| | | | 1,792 9 2 |
| £5,861 | | | £6,209 14 5 |

S. B. NEWTON, T. L. WINN } *Hon. Auditors*
J. S. BERESFORD, *Hon. Treasurer*

| 1959 £ | | £ s. d. | £ s. d. |
|---|---|---|---|
| | *Furniture and Equipment:—* | | |
| | Balance at 1st October, 1959 .. .. | 268 9 0 | |
| 268 | *Less* Depreciation at 5% per annum .. | 34 4 0 | |
| | | | 234 5 0 |
| | *Investments at Cost:—* | | |
| 477 | 1200 National Savings Certificates plus accrued interest .. .. .. | 927 10 0 | |
| 576 | £691 5s. 10d. 2½% Consolidated Stock | 575 14 0 | |
| 485 | £500 4% Consolidated Stock .. .. | 485 6 3 | |
| — | £1180 3% Funding Stock 1959/69 .. | 1,000 5 0 | |
| 500 | (£500 3½% Defence Bonds) .. .. | — — — | |
| — | £1,000 5% Defence Bonds .. .. | 1,000 0 0 | |
| 597 | £600 5¼% Hertfordshire County Council 1965 .. .. .. .. .. | 597 9 6 | |
| 509 | £500 5¼% Corporation of London 1976/79 .. .. .. .. | 508 10 9 | |
| | (Approximate Market Value £4,545) | | 5,094 15 6 |
| 44 | *Income Tax Recoverable* .. .. .. | | 22 7 6 |
| | *Cash at Bank:—* | | |
| 972 | Westminster Bank Ltd. .. .. .. | 400 16 4 | |
| 1,428 | Post Office Savings Bank .. .. | 454 13 3 | |
| | | | 855 9 7 |
| | *Cash in Hand:—* | | |
| 5 | Honorary Treasurer .. .. .. | | 2 16 10 |
| £5,861 | | | £6,209 14 5 |

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.
FREDK. B. SMART & CO.,
*Chartered Accountants*,
22, Queen Street, London, E.C.4.

*9th November*, 1960.

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